(Insert in 625-205, Galileo Orbiter Functional Requirements Book)

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FUNCTIONAL REQUIREMENT

GALILEO ORBITER FLIGHT EQUIPMENT

PLASMA WAVE SUBSYSTEM

Denotes changes

1.0 SCOPE

This document establishes the functional requirements of the Galileo Orbiter plasma wave subsystem (PWS) which is used to investigate electric and magnetic waves in space plasmas.

2.0 APPLICABLE DOCUMENTS

The following documents form a part of this Functional Requirement.

NOTE

GLL-3-100, Galileo Orbiter Requirements and Constraints applies to this document. Requirements of other Galileo level-three documents may also be applicable. It is the responsibility of the user to adequately acquaint himself with the organization and pertinent content of the level-three documents, as well as with with the material contained herein.

Requirements

Jet Propulsion Laboratory

GLL-3-100	Functional Requirements, Galileo Orbiter Requirements and Constraints
GLL-3-110	Functional Requirements, Galileo Orbiter Functional Block Diagram and Interface Listings
GLL-3-170	Functional Requirements, Galileo Orbiter Functional Accuracies and System Capabilities
GLL-3-180	Functional Requirements, Galileo Orbiter Configuration
GLL-3-190	Functional Requirements, Galileo Orbiter Structural Design Criteria
GLL-3-200	Functional Requirements, Galileo Orbiter Inertial Properties
GLL-3-210	Functional Requirements, Galileo Orbiter
GLL-3-220	Functional Requirements, Galileo Orbiter Electronic Equipment Design
GLL-3-230	Functional Requirements, Galileo Orbiter Equipment List and Mass Allocations
GLL-3-240	Functional Requirements, Galileo Orbiter Environmental Design Requirements
GLL-3-250	Functional Requirements, Galileo Orbiter Power Profile and Allocation
GLL-3-260	Functional Requirements, Galileo Orbiter Electrical Grounding and Interfacing
GLL-3-270	Functional Requirements, Galileo Orbiter Data System Intercommunication Description and Requirements
GLL-3-280	Functional Requirements, Galileo Orbiter Telemetry Measurements and Data Formats
GLL-3-290	Functional Requirements, Galileo Orbiter Command Structure and Assignments
GLL-3-1110	Functional Requirement, Galileo Orbiter Support Equipment Functional Block Diagram and Interface Listings

DRAWINGS

Jet Propulsion Laboratory

10085825	Circuit Data Sheet Index and Guide
10086759	PWS Interface Control Drawing
10086769	PWS Interface Control Drawing

Jet Propulsion Laboratory

PD625-50	Galileo Orbiter Science Requirements Document
PD625-52	Project Galileo Policies and Requirements for Orbiter Science Investigations
PD625-232	Galileo Orbiter System Configuration Management Plan

3.0 FUNCTIONAL REQUIREMENTS

GENERAL

The function of the PWS shall be to measure the characteristics of wave electric and magnetic fields in the Jovian magnetospheric plasma. The scientific objectives of this investigation are to study the characteristics and origin of plasma waves in Jupiter's magnetosphere. The measurements obtained with the PWS will be used to analyze wave-particle interactions that play important roles in controlling the dynamics of the Jovian magnetosphere and to study satellite-magnetosphere interactions. As a secondary objective a study will be made of Jovian radio emissions.

3.2 Sensing and Analog Processing

The PWS shall use sensors capable of detecting wave electric fields and wave magnetic fields.

3.2.1 Frequency Coverage

The PWS shall measure wave phenomena at frequencies between 5 Hz and 160 kHz. The PWS shall also measure wave electric fields at frequencies in selected narrow bandpasses in the frequency range 100 kHz to 5.6 MHz.

3.3.2 Frequency Resolution

The PWS shall measure wave phenomena in four filter channels between 5 Hz and 50 Hz. Nominal bandwidths shall be ± 15 percent of the center frequency. The PWS shall have 112 filter channels between 40 Hz and 160 kHz with bandwidths of approximately ± 2 percent of the center frequency. The PWS shall also have 42 channels with 3 kHz bandwidths at frequencies between 100 kHz and 5.6 MHz. The Galileo 2.4 kHz power supply frequency shall be notched in each of these filter channels at frequencies above 400 kHz. The PWS shall also make high frequency resolution measurements with a wideband waveform receiver that will sample wave phenomena rapidly enough to enable reconstruction of the waveform in selectable bandwidths of 5 Hz to 1 kHz, 50 Hz to 10 kHz, and 50 Hz to 80 kHz.

3.2.3 Dynamic Range

The PWS shall make measurements over a dynamic range greater than 90 dB with spurious free response over a dynamic range greater than 70 dB.

3.2.4 Amplitude Resolution

The PWS shall resolve the amplitude of wave phenomena measured to within ±2 dB.

3.3 Data Processing

The instrument shall cycle through various filters, collecting, compressing, A to D converting, and formatting data for output. The output shall be in 1 of 4 a fixed format.

3.4 Signal Interfacing

The instrument shall contain a data interface with the command and data subsystem (CDS). This interface shall condition signals for communication with the CDS to provide instrument synchronization, mode selection, and data readout.

3.5 Power Conversion

The PWS shall accept 2.4 kHz power form the power/pyro subsystem (PPS) and convert it to the necessary voltages for circuit operation.

4.0 FUNCTIONAL DESCRIPTION

4.1 Major Functional Elements

The PWS shall consist of a four channel frequency spectrum analyzer, a 112 channel sweep frequency receiver, a wideband waveform receiver, a 42-channel high frequency receiver, a data processing unit, and electric dipole antenna assembly, a search coil magnetic antenna assembly, input electronics, a calibration generator, a search coil preamplifier supplemental heater, and a power supply. The PWS functional block diagram shall be as shown in Figure 1.

4.1.1 Four Channel frequency Spectrum Analyzer

The four channel frequency spectrum analyzer shall measure the amplitude of signals in four filter channels with a logarithmic compressor. The center frequencies and the nominal bandwidth of these four channels are shown in Table 1.

Table 1. Spectrum Analyzer Filter Characteristics

Compressor	Filter	Center Frequency (Hz)*	Frame Number
	4	5.62	1, 5, 9, 13, 17, 21 25 2, 6 10, 14, 18, 22, 26 3, 7, 11, 15, 19, 23, 27 4, 8, 12, 16, 20, 24, 28

*Nominal bandwidth of ± 15%

4.1.2 One-Hundred Twelve Channel Sweep Frequency Receiver

The 112 channel sweep frequency receiver shall measure the amplitude of signals in 112 filter channels with four logarithmic compressors. The center frequencies and bandwidth of these 112 channels are shown in Table 2.

4.1.3 Wideband Waveform Receiver

The wideband waveform receiver shall sample and convert to digital form with 4-bit accuracy the waveforn of the signal received by an automatic gain control (AGC) receiver rapidly enough to allow reconstruction of the waveform in one of three bandpasses: 50 Hz to 10 kHz, 40 Hz to 80 kHz, or 5 Hz to 1 kHz. This hi-rate data shall be supplied, serially to the bulk memory through a special purpose interface, similar to the SSI hi-rate data. The waveform receiver shall operate in one of three hi-rate modes and a waveform survey mode (data included in LRS format) as listed in Table 3.

4.1.4 Forty-two Channel High Frequency Receiver

The forty-two channel high frequency receiver shall measure the amplitude of signals in forty-two filter channels with one logarithmic compressor. The center frequencies of these forty-two channels are shown in Table 4. The nominal bandwidth of these channels is 3 kHz.

GALILEO PLASMA WAVE SUBSYSTEM (PWS)

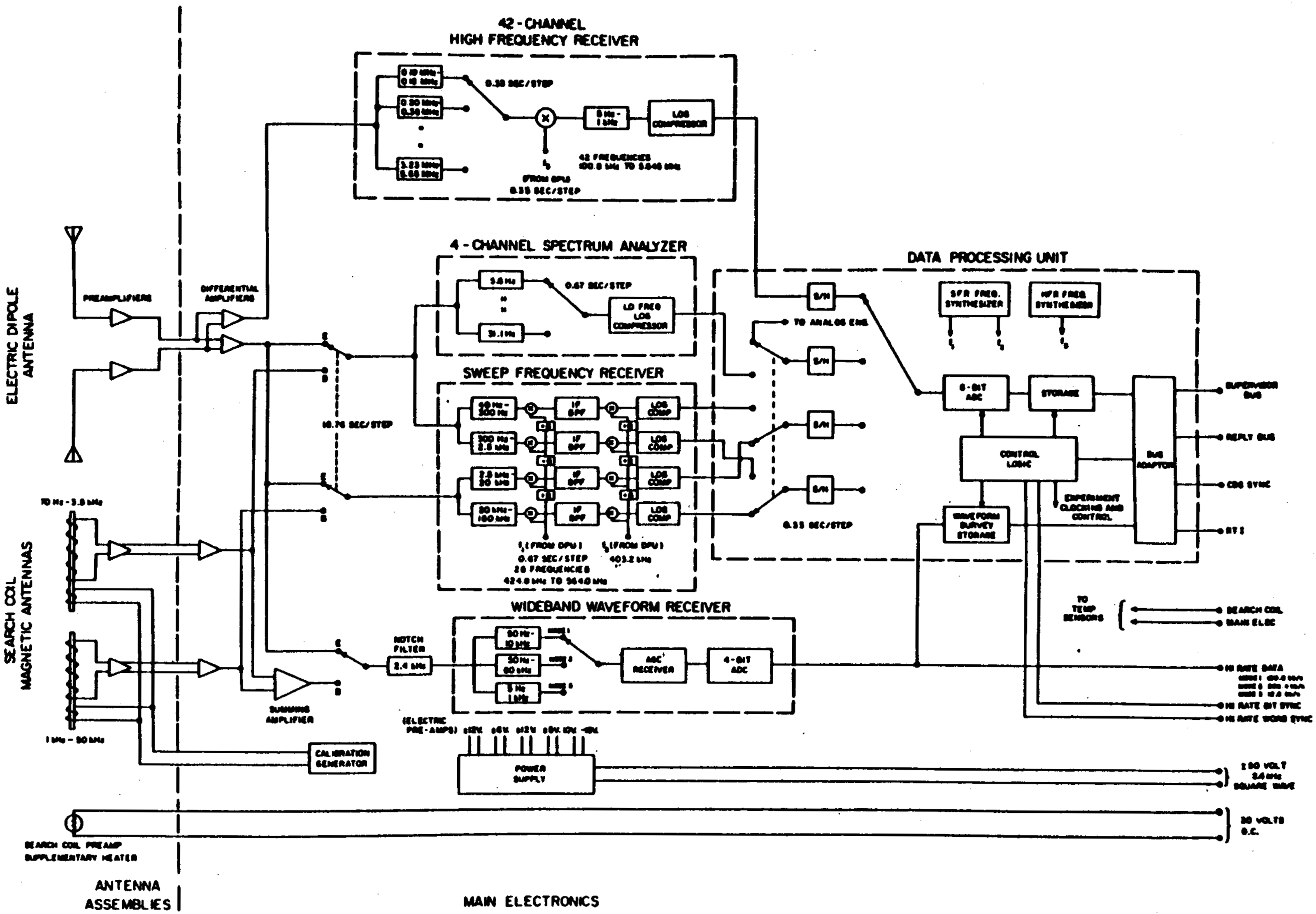


Figure 1. Functional Block Diagram

Table 2. SWEEP FREQUENCY RECEIVER FILTER CHARACTERISTICS

Band No.	Filter No.	Center Frequency (Hz)	Bandwidth (Hz)
	1	42.1	
	2	45.6	
	3	49.0	
	4	52.5	
	5	56.0	
	6	59.6	
	7	66.7	
	8	70.4	
	9	77.7	
	10	81.5	
	11	89.0	
	12	96.7	
	13	104.5	
1	14	112.5	±5.2
	15	120.6	
	16	128.9	
	17	137.3	
	18	150.2	
	19	158.9	
	20	172.5	
	21	186.4	
	22	200.7	
	23	215.5	
	24	235.9	
	25	251.7	
	26	268.0	
	27	290.6	
	28	314.1	
	29	337	
	30	364	
	31	392	
	32	420	
	33	448	
	34	476	
	35	534	
	36	563	
	37	622	
	38	652	
	39	712	
	40	774	
	41	836	

Band No.	Filter No.	Center Frequency (Hz)	Bandwidth (Hz)
	42	900	
	43	965	
	44	1031	
	45	1098	
	46	1201	
	47	1272	
	48	1380	
	49	1491	±15
2	50	1606	
	51	1724	
	52	1887	
	53	2013	
	54	2144	
	55	2325	
	56	2513	
	57	2.70 kHz	
	58	2.91	
	59	3.14	
	60	3.36	
	61	3.58	
	62	3.81	
	63	4.27	
	64	4.50	
	65	4.98	
	66	5.21	
	67	5.70	
	68	6.19	
	69	6.69	
3	70	7.20	±90
	71	7.72	
	72	8.25	
	73	8.78	
	74	9.61	
	75	10.17	
	76	11.04	
	77	11.93	
	78	12.85	
	79	13.79	
	80	15.09	
	81	16.11	
	82	17.15	

Band No.	Filter No.	Center Frequency (kHz)	Bandwidth (Hz)
	83	18.59 kHz	
	84	20.10	
	85	21.6	
	86	23.3	
	87	25.1	
	88	26.9	
	89	28.7	
	90	30.5	
	91	34.2	
	92	36.0	
	93	39.8	
	94	41.7	
	95	45.6	
	96	49.5	
	97	53.5	
4	98	57.6	±720
	99	61.7	
	100	66.0	
	101	70.3	
	102	76.9	
	103	81.4	
	104	88.3	
	105	95.4	
	106	102.8	
	107	110.3	
	108	120.7	
	109	128.9	
	110	137.2	
	111	148.8	
	112	160.8	

4.1.5 Data Processing Unit

The data processing unit shall perform sampling, 8-bit analog-to-digital conversion, storage, and routing of data from the spectrum analyzer, the sweep frequency receiver, and the high frequency receiver. The data processing unit shall generate clocking and timing pulses from signals received on the CDS bus. The data processing unit shall provide a bus adapter to interface between the CDS bus and the PWS. The data processing unit shall also collect and route sampled data from the waveform receiver in two bandpasses, 50 Hz to 10 kHz and 5 Hz to 1 Hz, when it is in the Waveform Survey Mode. A fixed number (280) of these samples shall be collected at a rate of 100.8 or 12.6 kb/s, stored in the data processing unit, and clocked into the low rate science format at an effective rate of 120 b/s.

Table 3. Wideband Waveform Receiver Operating Modes

Mode	Bandwidth	Hi-Rate Data Rate
Mode 1	50 Hz - 10 kHz	100.8 kb/s
Mode 2	50 Hz - 80 kHz	806.4 kb/s
Mode 3	5 Hz - 1 kHz	12.6 kb/s
Waveform Survey Mode (Mode 4)	50 Hz -10 kHz	100.8 kb/s, 12.6 kb/s alternating every 9.3 sec. (14 LRS frames)

Note: Data rate is rate at which data is clocked into the CDS bulk memory. Effective data rates in spacecraft telemetry will be less than or equal to these rates, depending on how much data is clocked into the telemetry stream.

Table 4. High Frequency Receiver Filter Characteristics

1 F Filter (MHz)	Channel Number	Center Frequency (MHz)
	1	0.1008
	2	0.1134
0.10-	3	0.1260
0.18	4	0.1386
	5	0.1512
	6	0.1638
	7	0.1764
	8	0.2016
	9	0.2268
0.20-	10	0.2520
0.35	11	0.2772
	12	0.3024
	13	0.3276
	14	0.3528
	15	0.4032
	16	0.4536
0.40-	17	0.5040
0.71	18	0.5544
	19	0.6048
	20	0.6552
	21	0.7056
	22	0.8060
	23	0.9070
0.81-	24	1.008
1.41	25	1.109
	26	1.210
	27	1.310
	28	1.411
	29	1.613
	30	1.814
1.61	31	2.016
2.82	32	2.218
	33	2.419
	34	2.621
	35	2.822
	36	3.226
	37	3.629
3.23	38	4.032
5.65	39	4.435
	40	4.838
	41	5.242
	42	5.645

4.1.6 Electric Dipole Antenna Assembly

The electric dipole antenna assembly shall receive plasma wave electric fields with two deployable elements. Two preamplifiers integral with the assembly shall be used between the antenna elements and the main electronics package.

4.1.7 Magnetic Antenna Assembly

The magnetic antenna assembly shall receive plasma wave magnetic fields with two search coil magnetometers covering the frequency ranges 70 Hz to 3.5 kHz and 1 to 50 kHz. A preamplifier shall be used between each search coil and the main electronics package.

4.1.8 Input Electronics

Input electronics consisting of differential amplifiers, analog switches, notch filters, and drivers shall route and condition the signal between the two antenna assemblies and the major subassemblies within the main electronics package.

4.1.9 Calibration Generator

A calibration generator shall be provided to supply a calibration signal to the search coil magnetic antennas. This calibration signal shall consist of a one volt peak-to-peak square wave at 960 Hz. Calibration data will be processed by the PWS similar to normal science data.

4.1.10 Power Supply

The power supply shall convert the ±50 volt, 2.4 kHz power for the orbiter into regulated voltages required by the instrument.

4.1.11 Search Coil Preamplifier Supplemental Heater

To maintain suitable temperature for the search coil preamplifier, a supplemental electrical heater shall be provided. This heater will be switched by the CDS and powered from the S/C 30 VDC supply.

4.2 Data Processing and Format

PWS commands from CDS for instrument control will be shown in GLL-3-290, Command Structure and Assignments. Telemetry will be shown in GLL-3-280, Telemetry Measurements and Data Formats. Data bus protocol will be as shown in GLL-3-270, Galileo Orbiter Data System Intercommunication Requirements.

4.2.1 Lo-Rate Data

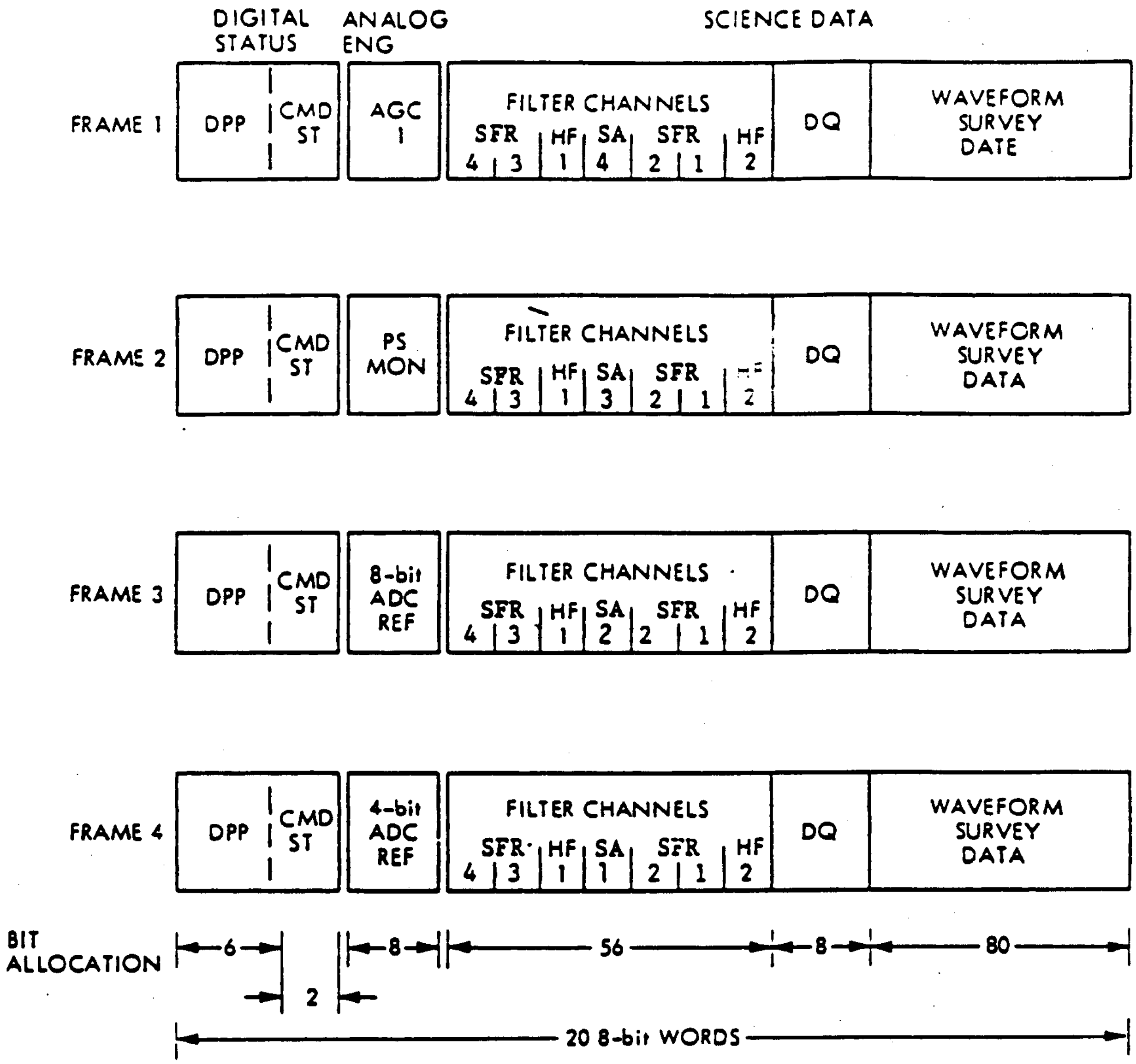
Data processing for the PWS lo-rate data shall consist of performing analog-to-digital conversions of data from the spectrum analyzer, sweep frequency receiver, the waveform receiver, and the high frequency receiver; storing the digitized data; and sending data to the CDS through the bus adapter. All PWS lo-rate science data shall be clocked serially to the CDS bus in one block of 18 eight-bit words. One 8-bit digital status word and one 8-bit analog engineering word will also be provided immediately preceding this 18-word block of science data. This results in a total block of 20 8-bit words at an effective data rate of 240 bits per second. The CDS will provide commands to enable the PWS to control the switching, sampling, and routing of these data. The format for the PWS science and engineering words is shown in Figure 2. The position of the high frequency receiver channels in the lo-rate science format is shown in Table 5. The position of the sweep frequency receiver channels in the lo-rate science format is shown in Table 6.

4.2.2 Hi-Rate Data

Data processing for the PWS hi-rate data shall consist of performing an analog-to-digital conversion of sampled data from the waveform receiver and routing that data to the CDS bulk memory via the hi-rate data interface. Appropriate synchronizing words shall be provided to enable the CDS to clock the data into the bulk memory. The Format for the hi-rate data is shown in Figure 3.

4.2.3 PWS Digital Status

The PWS shall make status measurements in the PWS digital status word as shown in Figure 4 and GLL-3-280.



ONE FRAME = 0.67 seconds
ONE SPECTRAL SCAN = 28 FRAMES
ONE SAMPLE OF BOTH E & B = 56 FRAMES
ONE WAVEFORM SURVEY SAMPLE = 14 FRAMES
SAMPLES OF BOTH WAVEFORM SURVEY
FREQUENCY RANGES = 28 FRAMES
ONE HIGH FREQUENCY RECEIVER SAMPLE = 28 FRAMES
ONE SFR SAMPLE = 28 FRAMES

DPP = DIGITAL PERFORMANCE PARAMETERS
DQ = DATA QUALITY
CMD ST. = COMMAND STATUS
HF = HIGH FREQUENCY RECEIVER CHANNEL
SFR = SWEEP FREQUENCY RECEIVER CHANNEL
SA = SPECTRUM ANALYSER CHANNEL

Figure 2. PWS Low Rate Science Format

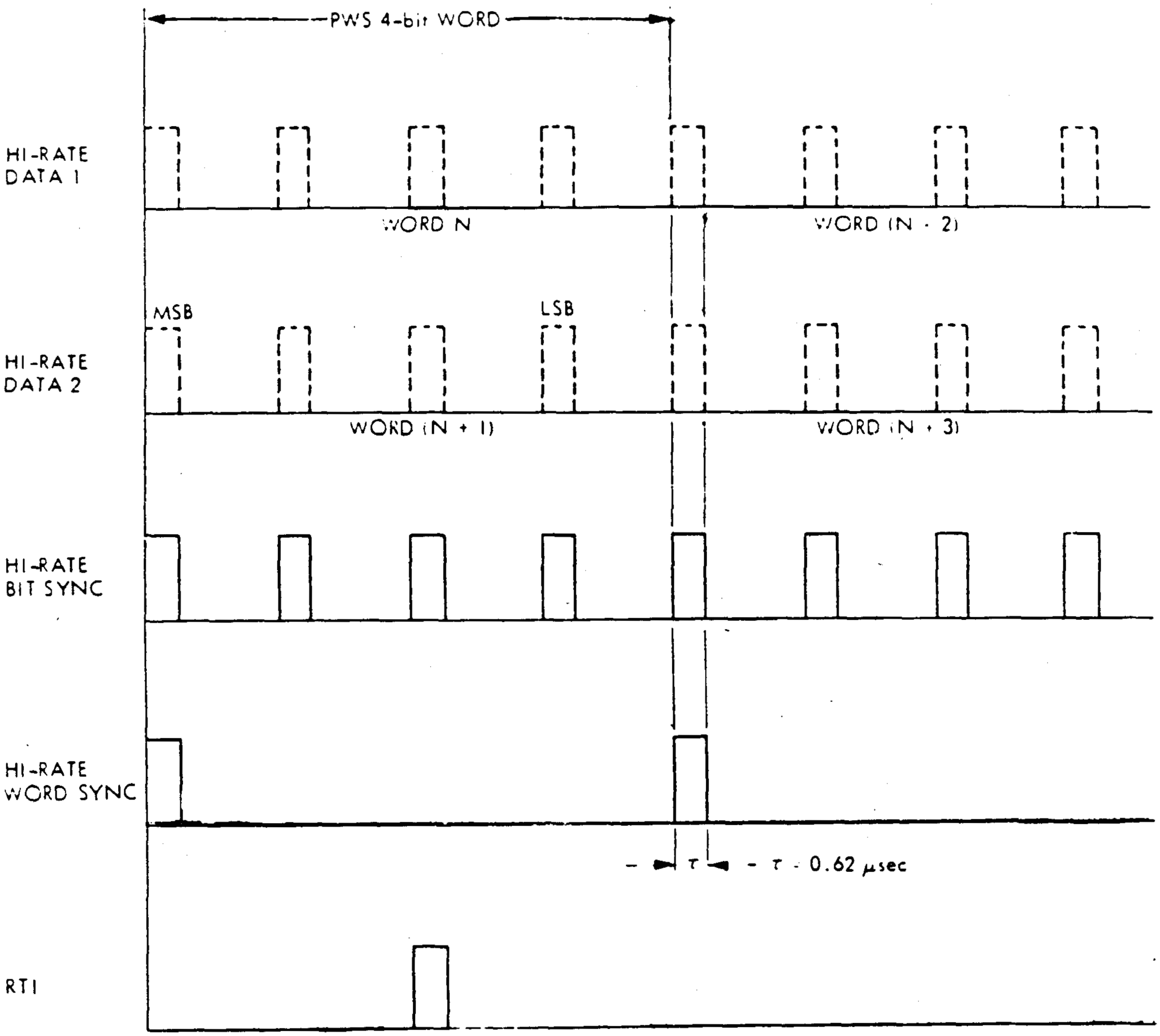
Table 5. Position of High Frequency Receiver Data in PWS Low-Rate Science Format

Frame No.*	HF 1* (Filter No.)	HF 2* (Filter No.)
1	15	1
2	22	1
3	29	8
4	36	8
5	16	2
6	23	2
7	30	9
8	37	9
9	17	3
10	24	3
11	31	10
12	38	10
13	18	4
14	25	4
15	32	1
16	39	11
17	19	5
18	26	5
19	33	12
20	40	12
21	20	6
22	27	6
23	34	13
24	41	13
25	21	7
26	28	7
27	35	14
28	42	14

*See Figure 2 & Figure 4.

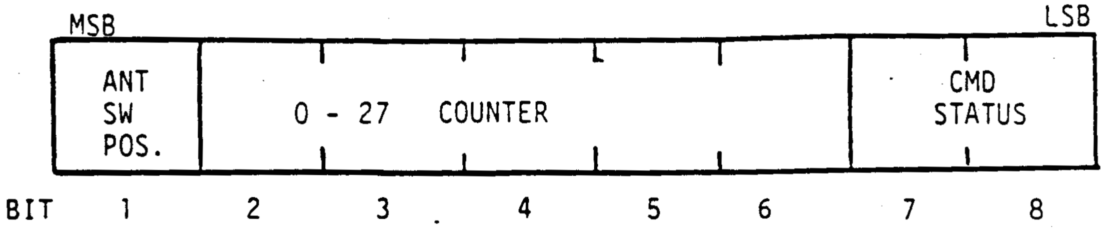
Table 6. Position of Sweep Frequency Receiver Data in Low-Rate Science Format

Frame No.	SFR 1 (Filter No.)	SFR 2 (Filter No.)	SFR 3 (Filter No.)	SFR 4 (Filter No.)
1	1	29	57	85
2	2	30	58	86
3	3	31	59	87
4	4	32	60	88
5	5	33	61	89
6	6	34	62	90
7	7	35	63	91
8	8	36	64	92
9	9	37	65	93
10	10	38	66	94
11	11	39	67	95
12	12	40	68	96
13	13	41	69	97
14	14	42	70	98
15	15	43	71	99
16	16	44	72	100
17	17	45	73	101
18	18	46	74	102
19	19	47	75	103
20	20	48	76	104
21	21	49	77	105
22	22	50	78	106
23	23	51	79	107
24	24	52	80	108
25	25	53	81	109
26	26	54	82	110
27	27	55	83	111
28	28	56	84	112



NOTE: ALTERNATE 4-BIT WORDS ARE CLOCKED ON PARALLEL DATA LINES

FIGURE 3. PWS Hi-Rate Data Format



BITS 1-6 DIGITAL PERFORMANCE PARAMETERS

BIT 1 Antenna Switch Position
0 = E
1 = B

BITS 2-6 0-27 counter

0-27 counter increments once per LRS frame; 0-27 counter-frame No. minus one (1).

Waveform survey data: frame No. 1-14 is waveform survey low frequency range (5Hz - 1 kHz), frame No. 15-28 is waveform survey high frequency range (50Hz - 10 kHz).

Other science data: see Table 1, Table 5, and Table 6.

BITS 7-8 COMMAND STATUS

Frame 1	CMD WORD, BITS 1-2
Frame 2	CMD WORD, BITS 3-4
Frame 3	CMD WORD, BITS 5-6
Frame 4	CMD WORD, BITS 7-8

(SEE FIGURE 6 FOR CMD WORD DEFINITION)

Figure 4. PWS Status Word

4.3 Operating Modes

The PWS shall operate in the operating modes shown in the PWS state diagram shown in Figure 5. The PWS command format is shown in Figure 6 and GLL-3-290. Commands are issued by the CDS and may be either ground commands or sequenced commands.

5.0 INTERFACE DEFINITION

5.1 Electrical Interfaces

5.1.1 General

a. Basic requirements for electrical grounding, electrical bonding, electrical interface circuits, and electromagnetic compatibility are contained in GLL-3-260, Electrical Grounding and Interfacing.

b. Specific system-level requirements for electrical interface circuits and ground are contained in the applicable circuit data sheets. See JPL Drawing 10085825, Circuit Data Sheet Index and Guide.

c. All spacecraft flight and umbilical interface circuits, e.g., sub-system-subsystem, subsystem-launch vehicle, and subsystem-support equipment through the umbilical connector, are listed in GLL-3-110, Functional Block Diagram and Interface Listings.

d. All spacecraft non-flight circuits, including direct access circuits, are listed in GLL-3-1110, Support Equipment Functional Block Diagrams and Interface Listings.

5.1.2 Power/Pyro Subsystem (PPS)

5.1.2.1 2.4 kHz Power (PPS)

The PPS will provide commandable on-off control of the 2.4 kHz, 50 V rms power.

5.1.2.2 30V DC Power

The PPS will provide commandable on-off control over a single interface for the search coil preamplifier supplemental heater.

5.1.3 PWS - PWS Sensor Interface

5.1.3.1 Electric Antenna Preamplifier - Main Electronics

The interface between the electric antenna preamplifiers and the main electronics includes positive and negative 11 volt power and signals from both preamplifiers.

5.1.3.2 Magnetic Antenna Preamplifiers - Main Electronics.

The interface between the magnetic antenna preamplifiers and the main electronics includes positive and negative 11 volt power, signals from both preamplifiers, calibration signal to the search coils, and preamp temperature.

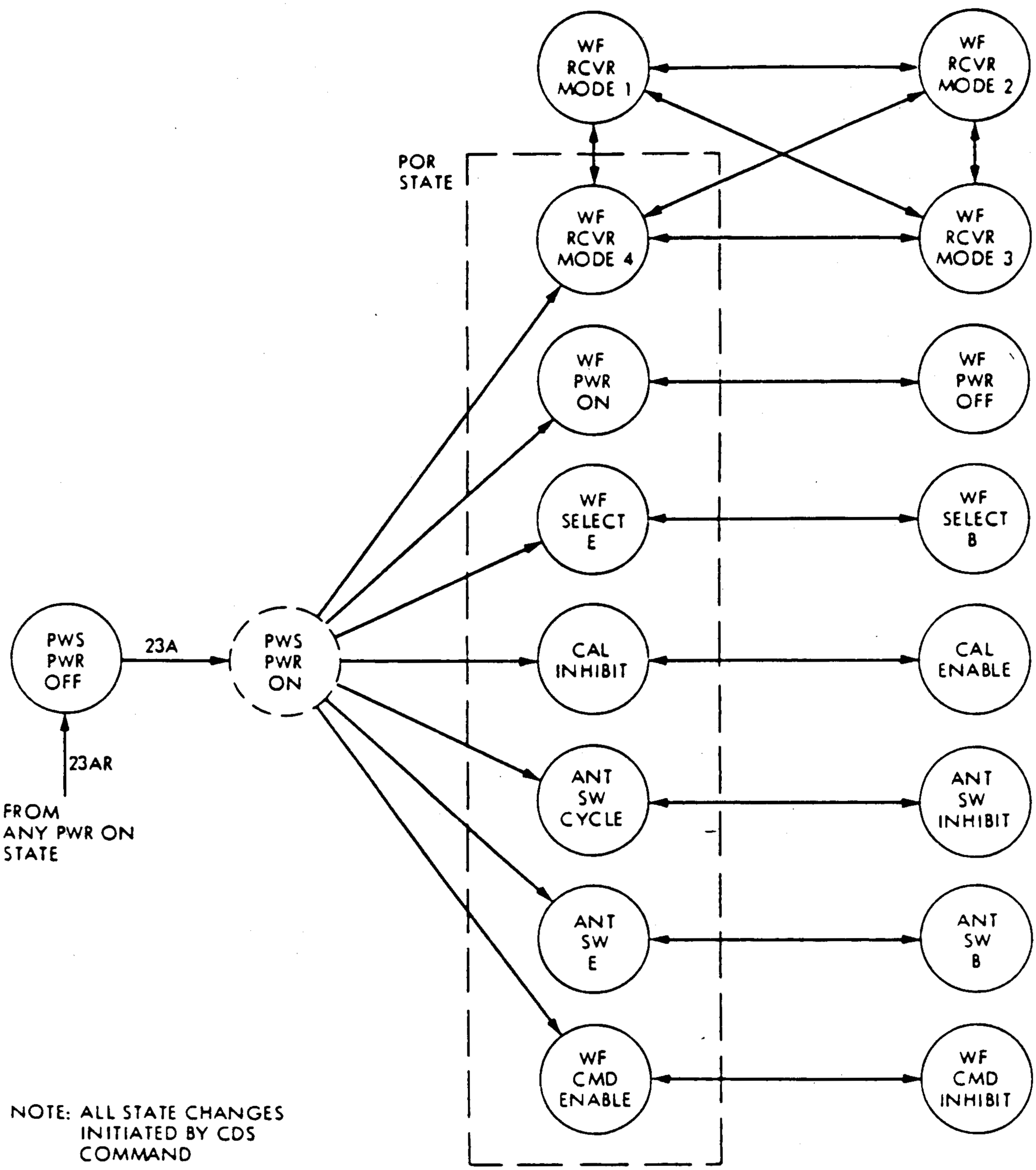


Figure 6. PWS State Diagram

CDS BUS COMMAND FORMAT*

PSEUDO ID	1	1	0	1	0	1	1	1
ADDR HI **	0	0	0	0	0	0	0	0
ADDR LO **	0	0	0	0	0	0	0	0
DATA	8-bit CMD							

*THERE ARE OTHER BYTES IN THIS BUS TRANSACTION. THESE ARE THE ONES OF INTEREST TO PWS COMMAND DECODING CIRCUITRY.

**ADDR HI AND ADDR LO ARE IDENTICAL FOR PWS COMMANDS (0 0 0 0 0 0 0 0) AND SPACECRAFT TIME TRANSACTIONS (1 1 1 1 1 1 1 1).

DEFINITION OF 8-bit CMD WORD

MSB LSB

	WF CMD INHIBIT/ ENABLE	ANT SW	ANT SW INHIBIT/ CYCLE	CAL ENABLE/ INHIBIT	WF SELECT	WF PWR	WF RECEIVER MODE	
BIT	1	2	3	4	5	6	7	8

BIT 1	WF CMD INHIBIT/ENABLE	0 = ENABLE	1 = INHIBIT
BIT 2	SA ANT SW	0 = E	1 = B
BIT 3	ANT SW INHIBIT/CYCLE	0 = CYCLE	1 = INHIBIT
BIT 4	CAL ENABLE/INHIBIT	0 = INHIBIT	1 = ENABLE
BIT 5	WF SELECT	0 = E	1 = B
BIT 6	WF PWR	0 = ON	1 = OFF
*BITS 7-8	WF RCVR MODE	00 = WF SURVEY	
		01 = 100.8 kb/sec	
		10 = 806.4 kb/sec	
		11 = 12.6 kb/sec	

*WF COMMANDS (BITS 5,6,7, AND 8) ARE IMMEDIATE AND INITIATED ONLY WHEN BIT 1, WF CMD INHIBIT/ENABLE IS EQUAL TO 0. ALL OTHER COMMANDS ARE DELAYED UNTIL START OF INSTRUMENT CYCLE (28 LRS FRAMES).

Figure 6. PWS Command Format

7.2 Power

Power consumption of the PWS shall be as specified in GLL-3-250, Power Profile and Allocations. Power expressed herein is for information only: 5.92 W, waveform receiver power **OFF** ; 6.8 W, waveform receiver power **ON** . The power for the supplementary electrical heater shall be 3.00 W.

7.3 Volume

The volume of the PWS shall be as specified in ICDs 10086759 and 10086769, and GLL-3-180.

7.4 Environmental

The PWS shall be designed to operate within specification over the qualification temperature range, which is:

a. Main Electronics -20/+75°C

b. Mag Pre Amp -35/+75°C

c. Elect Pre Amp -45/+75°C

d. Search Coils -125/+75°C

e. Dipole Antenna Elements -196/+75°C

In Addition, the PWS shall be compatible with all the requirements of GLL-3-240, Environmental Design Requirements, and GLL-3-210, Design Criteria for Temperature Control.

7.5 Packaging

The PWS shall be packaged in accordance with the applicable sections of GLL-3-220, Electronic Equipment Design.

7.6 Identification and Marking

The PWS shall be identified in accordance with ICDs 10086759 and 10086769; Section VII, Part F, Configuration Management, of PD635-52, Project Galileo Policies, and Requirements for Orbiter Science Investigations; and Section VII, Equipment Identification and Marking, 625-232, Galileo Orbiter Configuration Management Plan.

7.7 Inertial Properties

The PWS shall be in accordance with the applicable sections of GLL-3-200, Inertial Properties.

7.8 Structural Design

The structural design of the PWS shall be in accordance with GLL-3-190, Structural Design Criteria.

8.0 SAFETY CONSIDERATIONS

The PWS shall constitute no unusual safety hazard. Special handling is required for the RHUs. The search coils must be protected from large alternating magnetic fields.

9.0 SPECIAL REQUIREMENTS

9.1 Oscillator Synchronization

In orbiter subsystems, all oscillator circuits and countdown circuits in the range of 5 hz to 6 MHz will be a harmonic of the 2.4 kHz power frequency unless otherwise approved by waiver.

9.2 Electromagnetic Interference

Electric and magnetic field interference from other subsystems measured at the PWS antenna assemblies should be below levels specified in PD625-50, Galileo Orbiter Science Requirements Document. These levels are repeated in Table 7, and are approximately equivalent to the PWS instrument sensitivity. Allowable subsystem emission levels are shown in GLL-3-240. If all subsystems meet these requirements then the maximum science data will be possible.

Table 7. Maximum EMI Levels

Electric Field Interference at Electric Antenna Assembly

Frequency Range	Integrated Electric Field
1 Hz - 4 kHz	0.5 V/m in 30% bandwidth
4 kHz - 400 kHz	0.5 V/n in 15% bandwidth
1 Hz - 2 kHz	50 V/M
250 Hz - 85 KHz	50 V/m
400 KHz - 10 MHz	0.5 V/m in 1 kHz bandwidth between harmonics of 2.4 kHz power supply frequency

Magnetic Field Interference at Magnetic Antenna Assembly

Frequency Range	Integrated Magnetic Field
1 Hz - 1 kHz	40 in 30% bandwidth
1 kHz - 100 kHz	30 in 15% bandwidth
1 Hz - 2 kHz	2
250 Hz - 85 kHz	1

9.3 Equipotential Spacecraft

The use of an equipotential spacecraft to control spacecraft charging will assist in controlling electromagnetic radiation from the orbiter and possible electric interference from discharges on the surface of the orbiter resulting from differential charging.

REVISION PAGE

Revision	Date	ECRs Incorporated	Comments
Original Issue	9 Oct 1979		
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PD 625-205

Galileo

LEVEL 3 FLIGHT SOFTWARE REQUIREMENTS, GLL 3-310

PHASE II

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5.0. Overview of 3-310

This document summarizes at Level 3 the CDS processing associated with the Phase 2 flight s/w changes. For ease of comparison, the instruments are covered in the same order as in the Level 2 document. For each instrument the data pickup is described, followed by a description of the processing needed to form the packets. Finally there is a brief description of the changes in the instruments' flight s/w.

5.0.1. Use of Fill Data

Whenever the downlink rate exceeds the rate of RT data generation and PB data are not available, CDS will fill the excess capability with high-rate PWS data collected from the PWS LPW buffer, placed into 442-byte packets (including header), and then into RT VCDU's. These are sent to the TLM build process as needed.

5.0.2. Buffer Management

CDS will provide a large (70K) Multi-use Buffer. This buffer will be used to temporarily store raw DMS tape data prior to processing, raw RRCC data, processed DMS tape data (VCDUs) prior to downlink, processed RRCC data (VCDUs), and processed R/T science data (VCDUs) prior to downlink.

CDS will provide a smaller (4K) Priority Buffer. This buffer will be used to temporarily store engineering and OPNAV processed data (VCDUs). Ready data in this buffer will always be given priority over data in the multi-use buffer when constructing the downlink frame. Capability will be provided (via 6TMCHG) to store the engineering data during periods of no downlink.

CDS will use the 13.5K Imaging ICT line buffer for three purposes. About 5K will be used to process NIMS PB data when this function is active. At other times about 12K will be used to support PPR Burst-to-tape. Finally, when the SSI playback data is being processed, the full buffer will be used to select 8X8 blocks to send to AACS for ICT compression. In the case of the NIMS data, about 15 minutes is required after the data is acquired to process and packetize it. The ICT data clear in about one RIM.

5.0.3. CDS Internal Fault Protection Changes

CDS will terminate the new phase 2 non-redundant processes after detecting any privileged or non-privileged CDS internal fault if that fault triggers an SFP response. Note that S/C Safing SFP response creates a CDS non-privileged error.

CDS will terminate the new phase 2 non-redundant processes prior to executing any SFP response to provide adequate resources to execute the routine. Excepted from this requirement are the "normal" SFP functions of Thruster Firing Imminent (TFI), Thruster Firing All Clear (TFAC), and the LLM SFP Temperature Monitors.

CDS will initiate S/C Safing SFP response after any fault which terminates the new phase 2 non-redundant processes.

CDS will provide for autonomous detection of a despun bus reset and will then recover the affected string, request a new (TBD) SFP response, and will continue the execution of the stored sequence. Functions not compatible with this requirement will be moved out of the despun LLMs.

5.0.4. System Fault Protection Changes

While most of system fault protection is unchanged and provides the same level of single fault tolerances as currently exists, selected system fault protection functions will be changed in order to save memory, and to make responses compatible with the new LGA functions.

5.0.4.1. Algorithm Deletions

Delete system fault protection algorithms not required during the orbital operations period. These include:

a. RPM Overpressure (monitor and response)
b. Celestial Reference Loss (response)
c. AACS_INIT_C (relay/joi sections of the response)
d. UVREC_C (relay/joi sections of the response)
e. DMS Recovery (move non-critical mode portions to UVREC_C)
f. Critical Mode Operation
g. Critical Mode SAFING response
h. DBUM Swap

5.0.4.2. Modifications to Existing Algorithms

Modify system fault protection algorithms as required to support the LGA mission. These will include:

a.	SAFING	Delete VEEGA conditionals (S_TWTA_HI, FPWS_COLD), Bay E heater.
b.	TFAC	PPR commands stored in PGVs
c.	RPMSAFE	Replace RCT-NIMS with Bay E heater
d.	UVREC	Place PLS in a safe condition after a UV-trip (PLS Instrument Power OFF, Replacement Htr ON, Supplemental Htr ON)

5.0.4.3 Algorithm Addition--DBUSR

Add a new SFP algorithm which is requested by CDS internal FP after recovering from a Despun Bus Reset. This algorithm will issue only those commands necessary for S/C and subsystem safety when continuing the stored sequence after the despun bus reset. The response is limited to one command per 15 minor frames to allow concurrent execution with other ongoing activities. Commands are **TBD**.

5.05. Delete Unnecessary CDS Functions

CDS will delete functions which are no longer required in the LGA mission in order to reallocate memory to new functions. Functions to be deleted include Critical Operations Mode (including 6MARK FC).

5.06. Science Instrument Software Changes

The following table summarizes the changes which are being made in the software within the science instruments. The column labled "Class" indicates the size of the reprogramming as a fraction of the initial programming effort: Class 1 = <20%, Class 2 = 20%-40%, and Class 3 = 40%-60%.

Instrument	Class	Description
SSI	2	Slow image readout 2x2 sum at low rate On-chip mosaic
NIMS	2	Edit mirror position, λ Decrease housekeeping data Add realtime data
PPR	0	None
EUV	1	Store spectrum by sector
UVS	1	Change observational modes
MAG	2	Redesign optimal averager
DDS	1	Add lower data rate capability
PLS	3	Decrease cycle time, resolution Compress sensor data Minimize housekeeping data
PWS	0	None
EPD	3	Change to spin-based sampling Reduce channel sampling Minimize housekeeping data
HIC	0	Reconfigure for MRO's

5.07. Packet Format Summary

The table below shows a typical telemetry packet. The top row gives the names of the fields, the second row the size of the fields in bits, and the third row the data entered.

The first bit of the packet, the Time Included flag, is set to 1 for those packets which include a time field. The rest of the first byte is the Application ID, which is used to identify the source of the data and the format of the rest of the header. The next nine bits give the byte count of the data portion of the packet. Next is the 7-bit Sequence Number, which is a packet counter separately maintained for each Application ID, going from 0 to 127 and then rolling over to 0 again.

Next is the Format ID, which is not present for all Application IDs. It is used to give further information about the contents of the packet, typically giving the data rate or instrument mode.

Following is the optional time field, whose length and content depends on the needs of the ground data processing system. It is always included in packets with a Seq # of 0, and generally also when Seq # modulo some specified power of two is zero, *e.g.*, "every 16th packet." Time is also included in the first packet of a new "set" of data, such as the start of a record mode or switching a data stream from deselected to selected, indicating a break in the steady collection of data. In the example shown, the time field contains the minor frame count and the least significant two and a half bytes of the RIM count.

If the time field is missing, the Format ID is in the most significant nybble of a byte by itself.

MAG RT Data

Time inc.	App ID	Size	Seq #	Fmt ID	(Time)	Data1	Data2	...	Data 90
1	7	9	7	4	28	16	16	...	16
	MAG1				½R-R-R-mf				

5.1. SSI

5.1.1. SSI Data Pickup

In addition to continuing to supply 94.56 kb/s for HIM, 768 kb/s for IM8 and AI8, and 311.04 kb/s (372.48 including R/S) for IM4, SSI will supply 77.76 kb/s (93.12 including R/S) for HCA and 94.56 kb/s for HMA and HIS. It also will continue to supply 144 b/s (12 bytes per mf) status data for LPW.

5.1.2. SSI Processing in CDS

CDS does a lot of processing for SSI data. In all cases it deletes prepare-cycle data, header and fill. The location of these data is mode-dependent. CDS deletes the Reed-Solomon code from the compressed modes HCA and IM4. CDS has an editing process for uncompressed SSI science imaging data (windowing) and two types of compression (in AACS): an 8x8 ICT compressor at various commandable target compression ratios and a lossless compressor. CDS can apply either compressor or neither, with or without windowing. Windowing consists of saving only one sequence/PB-table-specified rectangular region of the image for compression and downlink. The window will be a multiple of 8 columns and 8 rows.

The ICT compressor operates fast enough to keep up with the 7.68 kb/s tape playback. It can accomodate playback-table-selectable target compression ratios ranging from 2:1 to 80:1. CDS will load into AACS optimized Q tables and Huffman tables indicated by the playback table. Another option is a fixed-size "truth window" of losslessly compressed data in an otherwise ICT-compressed image.

The specification of processes and parameters involves the usual PB table algorithm and parameter fields, plus a special second 8-byte PB table entry. The algorithm field of the first entry has two bits to specify the compression type and 1044-byte Huffman table to use (ICT-atmosphere, ICT-satellite, lossless, BARC), two bits to point to which of the 3 128-byte Q tables should be used, and one bit to specify the zigzag pattern. The parameter field is the Q factor.

The extra PB table entry specifies the windowing and truth window (if present). The first byte give the X coordinate of the pixel start of the window to be processed, the next byte gives the Y coordinate, the next byte gives the picture width, and the following byte the height all in 8-pixel units. To indicate that no windowing is being done, the first 4 bytes should be (0, 0, 100, 100). The last two bytes give the X and Y coordinates of the upper left corner of the losslessly-compressed 96 x 96 truth window (for ICT-compressed images only) in the same units. If no truth window is desired, both bytes should be 255.

In order to reduce the quantity of downlink data, none of the ground-specified (sequence or playback table) processing parameters are included in the data. The science team/MIPL is responsible for using the appropriate parameters from predicts for processing the data.

Each packet contains data from only one image. Except for the grouping of 8 lines of data together for the ICT, data are processed and returned in the same order in which they went onto the DMS. Time is included in the first data packet for each image and every 64^{th} packet.

The data from the ICT and lossless compression consist of a up to 100 strips of compressed data, each strip containing data from 8 lines (up to 100 8x8 blocks). Each block of data consists of Huffman codes from the 8x8 region followed by a 1-bit flag which is set to 1 if the attempted compression resulted in expansion. In the case of expansion, for ICT the data returned are truncated at 64 bytes, while for lossless compression the raw data are returned. The data from the compression blocks within each strip are packed into bytes with no gaps, but with up to 7 bits of zero fill after the last block in the strip, followed by a 32-bit sync code and a byte giving the strip number (1-100) of the data. The data field can be split across packet boundaries, but the sync code can not. Each packet for the BARC-compressed modes contains data from one line.

Each image has one special packet with housekeeping measurements associated with that image, along with AACS data (scan platform RA, DEC, and TWIST plus rotor CLOCK) corresponding to the time the SSI shutter was opened, obtained from the LPW recorded with the imaging data, along with the time for the image. For most modes the housekeeping data consist of two bytes per mf collected for 13 mf's. For the 2 1/3 second mode (AI8) it is four bytes per mf for 3 mf's. For details on this and for the subset of the housekeeping data which is put into the engineering telemetry see 3-280.

SSI imaging and status data can be deselected independently from the playback data stream.

SSI Imaging Data, Non-BARC-compressed Modes

Time inc.	App ID	Size	Seq #	Image #	(Time)	Data1	Data2	...	Data ≤511
1	7	9	7	4	28	8	8	...	8
	SSI1				½R-R-R-mf				

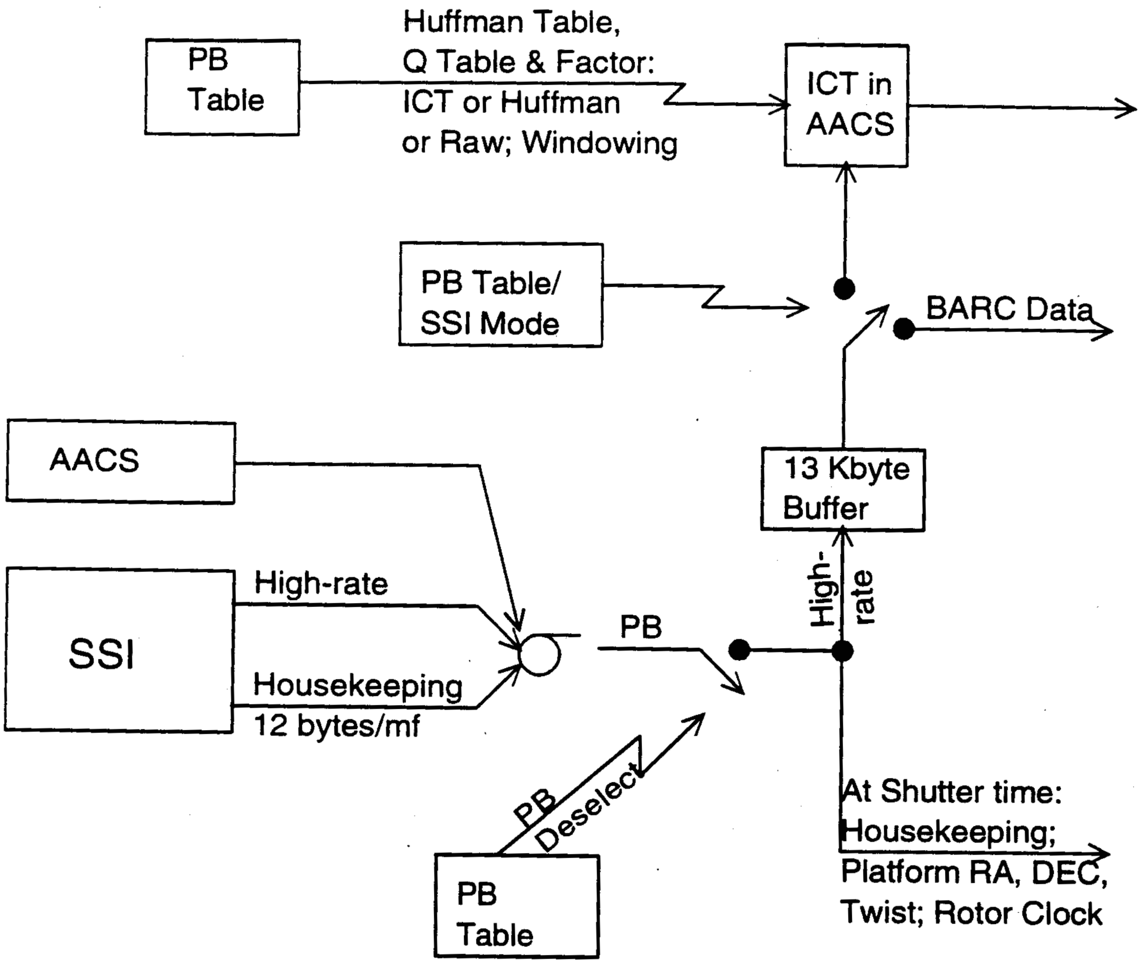
SSI Imaging Data, BARC-Compressed Modes (HCA, IM4)

Time inc.	App ID	Size	Seq #	Image #	(Time)	Data1	Data2	...	Data 324
1	7	9	7	4	28	8	8	...	8
	SSI2				½R-R-R-mf				

SSI Housekeeping

Time inc.	App ID	Size	Seq #	Image #	(Time)	Data1	Data2	...	Data 20 or 34
1	7	9	7	4	28	8	8	...	8
1	SSI3				½R-R-R-mf				

SSI Science & Housekeeping Data Flow in CDS



5.1.3. SSI Opnav Processing in CDS

In addition to the science processing for SSI data described above, there is also a different set of algorithms used for optical navigation. These involve finding and returning small windows around the limb/terminator (LT) of one extended body and using its computed position plus uplinked offsets to find and return square windows presumably containing star images. The algorithms can work either with recorded images or by doing realtime readouts of the SSI, using special commands to discard or read out a specified number of lines. The basic routine starts with finding the extended target body by doing 10 to 50 cycles of skip *n* lines and read *m* lines. For each set of *m* lines read, CDS scans each line looking for the two LTs presumed to be present. The first LT is marked by the finding of *i* consecutive pixels greater than a specified high threshold, and the second by finding *j* consecutive pixels below a specified dark threshold. In each case the (x,y) location of the LT and the values of the 16 pixels surrounding it in the line are saved for downlink.

CDS will use locations in the top 1/3 of the LT to compute the location of the upper cusp of the body. Uplinked offsets from this location determine the locations of the *k* (1 to 3) 20x20 windows surrounding star images which will be read out and downlinked along with the LT data. The stars must be below the top 1/3 of the extended body.

Note that for RT opnav, special commanding of SSI is needed to read out and to skip the specified lines, while recorded opnav takes some fancy DMS control.

One packet type will be used for the LT data and one for the star windows. Five to eight packets will be used for each extended body, and one packet for each star. Time is included once per image, and the packets are turned into VCDUs in the priority virtual channel.

RT Opnav Extended Body Limb/Terminator Data

Time inc.	App ID	Size	Seq #	(Time)	Data1	Data2	...	Data≤511
1	7	9	7	32	8	8	...	8
	OPN1			R-R-R-mf				

RT Opnav Star Window Data

Time inc.	App ID	Size	Seq #	(Time)	Data1	Data2	...	Data≤511
1	7	9	7	32	8	8	...	8
	OPN2			R-R-R-mf				

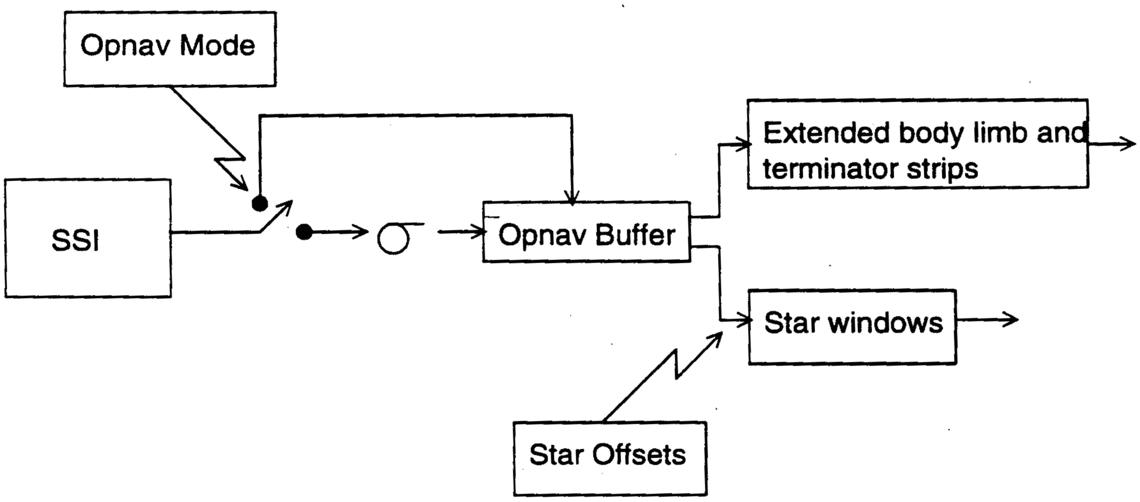
PB Opnav Extended Body Limb/Terminator Data

Time inc.	App ID	Size	Seq #	(Time)	Data1	Data2	...	Data≤511
1	7	9	7	32	8	8	...	8
	OPN3			R-R-R-mf				

PB Opnav Star Window Data

Time inc.	App ID	Size	Seq #	(Time)	Data1	Data2	...	Data≤511
1	7	9	7	32	8	8	...	8
	OPN4			R-R-R-mf				

SSI Opnav Data Processing in CDS



5.1.4. Changes in SSI Commands

The 36IP command is being modified to include a READOUT DISABLE function and a FLOOD/ERASE DISABLE utilizing two previously spare bits.

The 36IM command is being modified to include a CONTIGUOUS/SAMPLING READOUT selection and an HGA/LGA MODE selection utilizing two previously spare bits.

Because of the use of the previously spare bits in the above commands, the Spacecraft Expanded Block which has been used for SSI control (which also used two of the bits) is being deleted.

The opnav functions to read n lines and skip m lines will be accomplished using four new commands (see 3-290 for details):

36ONSV	SKIP VARIABLE = 5A, CV1, CV2
36ONS1	SKIP ONE = 5B
36ONRV	READ VARIABLE = A4, CV1,CV2,CV3
36ONR1	READ ONE = A5

5.2. NIMS

5.2.1. NIMS Data Pickup

The NIMS RT pickup is 32 bytes per RTI, and the pickup is made whether or not NIMS RT is selected. . The data are read from a dedicated location in NIMS memory.

For record modes, in addition to supplying 11.52 kb/s for existing modes MPW, HIM, HPW, IM8, AI8, and IM4, and for new mode HMA, NIMS also supplies 2.592 kb/s (plus 36 b/s status) for LNR, and 6.168 kb/s for LPU.

5.2.2. NIMS Data Processing in CDS

5.2.2.1. NIMS Realtime

Each 32-byte RT pickup consists of a flag byte, a length byte specifying the number of valid data bytes, and 0 to 30 data bytes followed by fill if needed, as illustrated below:

Flag	Length	Data / Fill

The format of the flag byte is given below, with a 1-bit being active:

MSB LSB

Start Cycle	End Cycle	End Packet	Start Packet	Long Cycle			

The normal situation is that a telemetry packet will contain one to several instrument data cycles. There is one mode, however, in which a cycle must be split into two packets, a situation indicated by having the Long Cycle bit set.

CDS reads NIMS RT at 32 bytes per mf, and outputs at 10 b/s. The seeming discrepancy in rates is handled by having CDS throw away most of the data, under the control of the length byte and the bits in the flag byte. When CDS is processing NIMS RT it starts by waiting for a Start Packet flag. It then starts looking for a Start Cycle flag, starting with the current 32-byte block. When it sees one it starts assembling data for a telemetry packet, using the number of bytes indicated in the length byte of the block. and it continues assembling data until it sees an End Cycle flag. If the same block includes an End Packet flag, the packet is sent off to the VCDU maker. Otherwise CDS waits for the next Start Cycle flag to repeat the data assembly process.

If the nominal 264-byte packet length is passed without an End Packet flag, and the Long Cycle flag was not set, CDS will output a 265-byte packet--the only time a NIMS packet is greater than 264 bytes. CDS will then wait for the End Packet flag before looking for the next Start Packet flag, and will put the time field in the next packet, since the normal ground algorithm for inserting time may not properly function.

If the Long Cycle flag is set at the start of a cycle, CDS will break up the next 528 data bytes into two packets, ignoring other flag bits, and will then wait for the next Start Packet flag.

A new NIMS command is being added to tell the instrument how many grating cycles to skip between those kept and how many cycles to put in a packet, so that it can properly set the bits in the flag byte. The proper use of this command and the proper operation of NIMS s/w are totally responsible for limiting NIMS to its 10 b/s RT allocation. CDS makes no checks.

When the appropriate RT mode is selected, and NIMS is not deselected from RT, CDS will continue to process the RT data stream even if a REC mode is entered which contains NIMS recorded data.

The time will be included in two situations: the first packet of a new rate and every 16th packet. Note that the mf/2 in the TIME field is a normal minor frame count, but with the high-order bit set if the data taking started in the second half of the minor frame, *i.e.*, in RTI 5-9.

NIMS RT Data

Time inc.	App ID	Size	Seq #	(Time)	Data 1	Data 2	...	Data ≤265
1	7	9	7	32	8	8	...	8
	NIMS1			R-R-R-mf/2				

5.2.2.2. NIMS Record/Playback

The algorithm descriptions here are valid only for data recorded from the Phase 2 NIMS s/w, and will not work to play back data recorded with the current s/w. Although the data rates are the same and the fecord format names are the same, the meaning of the bits is different. This is a potential problem, since according to current plans the JA/JOI data will be recorded with Phase 1 s/w and played back with Phase 2 s/w. Ways of handling the problem include additional capabilities to the CDS NIMS handler, and loading the new NIMS instrument s/w before the JA/JOI data are taken.

Each 96-byte NIMS data set starts with 11 bytes of header/housekeeping data, with format given below.

<table>
<tr><th></th><th>MSB</th><th></th><th></th><th></th><th></th><th></th><th></th><th>LSB</th></tr>
<tr><td>Byte1</td><td>HMF</td><td colspan="7">Contents Length</td></tr>
<tr><td>Byte2</td><td colspan="3">Hskpg Length</td><td>Cycle</td><td colspan="2">Gain</td><td>Mir.D</td><td>M</td></tr>
<tr><td>Byte3</td><td>M</td><td>M</td><td>M</td><td>M</td><td>M</td><td>M</td><td>M</td><td>M</td></tr>
<tr><td>Byte4</td><td>M</td><td>M</td><td>M</td><td>M</td><td>M</td><td>M</td><td>M</td><td>M</td></tr>
<tr><td>Byte5</td><td colspan="8">Half Minor Frame Count</td></tr>
<tr><td>Byte6</td><td colspan="8">Housekeeping 1</td></tr>
<tr><td>Byte7</td><td colspan="8">Housekeeping 2</td></tr>
<tr><td>Byte8</td><td colspan="8">Housekeeping 3</td></tr>
<tr><td>Byte9</td><td colspan="8">Housekeeping 4</td></tr>
<tr><td>Byte10</td><td colspan="8">Housekeeping 5</td></tr>
<tr><td>Byte11</td><td colspan="8">Housekeeping 6</td></tr>
</table>

In the table HMF is 1 for RTI 0 and 5 and is 0 otherwise, Contents Length is the sum of the header length (2 or 5) plus the housekeeping (0-6) plus the data (0-85), Hskpg Length is the number of valid housekeeping bytes in the packet, the Cycle flag is 1 at the start of a grating cycle, Mir.D is set to 0 to indicate downward mirror movement, the M bits constitute the detector mask, and the Half Minor Frame Count goes from 0 to 181 during each RIM. The Cycle flag, Gain, Mir.D, M bits, and Half Minor Frame Count are valid only when HMF is 1.

The header /housekeeping block is followed by 0-85 data bytes.

CDS double buffers the 96-byte data sets as read from the instrument, packs the valid header, housekeeping, and data bytes in an intermediate buffer (for rate averaging), and then sends the data to the DMS at the steady rate appropriate for the record mode.

On playback, for each half minor frame of NIMS data CDS will build a table (possibly sparsely-populated) of 20 mirror positions by 17 detectors, plus up to 30 bytes of housekeeping data. In building the table CDS takes into account the different mirror position offsets of the detectors--0 for detectors 1, 5, 9...; 1 for detectors 2, 6: ...; 2 for 3, 7, ...; and 3 for 4, 8, ...

CDS then determines which data to compress in its λ editor, which does a logical AND of the detector map in the data header with one pointed to by the PB table, and using only the λ's represented by a 1 bit.

In order to make the compression more efficient, CDS will perform dark suppression/normalization by subtracting a detector-dependent value from each number in the table, and will perform thresholding, which is simply replacing each table value with the maximum of itself and the threshold value.

CDS then sends data to the Rice compressor, 10 Mirror Positions at a time, for each kept detector.

If the compressor does not perform as well as expected, CDS will throw out 4 mirror positions from each end of the scan.

Since the Rice algorithm uses differences of successive values of each detector's as one means of compressing the data, the seed values will be returned once per RIM for robustness.

CDS will terminate the current packet and begin a new one (containing the time field) each time the RIM count of the recorded data rolls over.

The packet consists of header information followed by one or more subpackets, each of which has one of the two formats below:

	MSB							LSB
Byte1	0	Length$_{hi}$						
Byte2	Length$_{lo}$		Detector Mask$_{hi}$					
Byte3	Detector Mask$_{mid}$							
Byte4	Detector Mask$_{lo}$			RTI Mask				
Data1								
Data...								
Data$_{Len}$								

where Length is the number of data bytes, Detector Mask has 1 bits tor those detectors present in the data, and RTI Mask has 1 bits for those RTIs represented in the packet.

	MSB							LSB
Byte1	1	Zero Count						

where Zero Count is the number of consecutive half-minor-frames without any data.

That is, each subpacket either contains the data from one half-minor-frame or elst tells how many consecutive half-minor-frames there were with no data.

Subpackets are not split across packet boundaries unless the subpacket is longer than the packet.

CDS sends the packet to the PB virtual channel to be made into VCDUs. The time will be included in three situations: the first packet of each set of PB data and those packets which start at a RIM rollover, and when the sequence number rolls over. Even when the full time is not included, the mf/2 byte will be included.

CDS stores about 300 bytes of wavelength tables for the control of its PB editing.

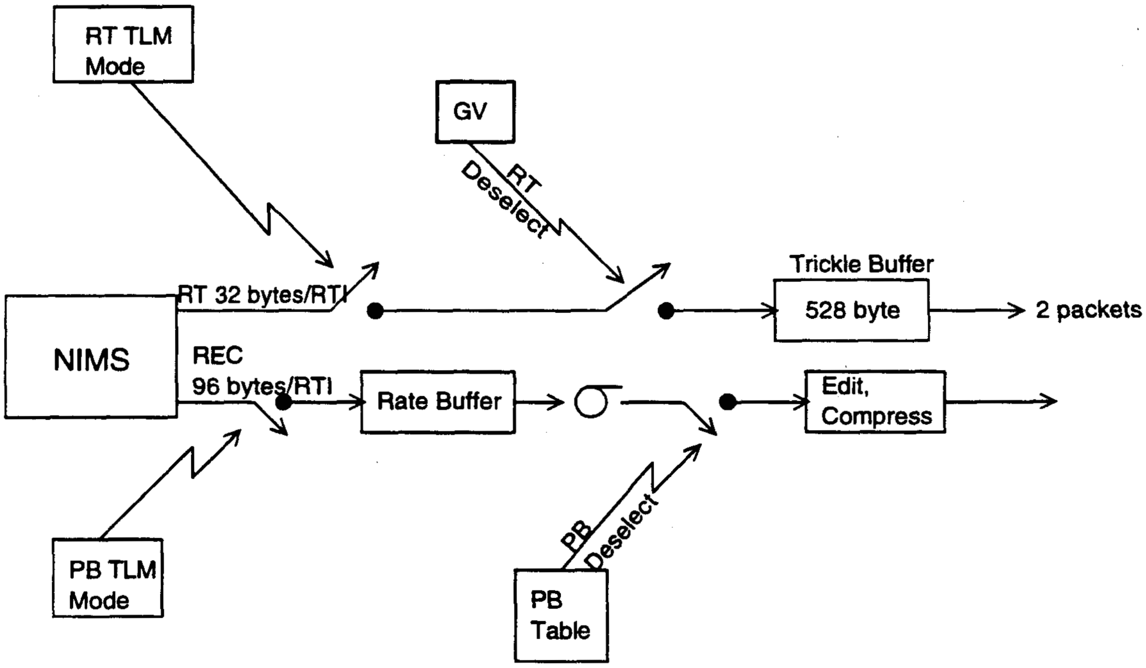
NIMS PB Data

Time inc.	App ID	Size	Seq #	Fmt ID	(Time)	MF/2	Data1	Data2	...	Data≤511
1	7	9	7	4	20	8	8	8	...	8
	NIMS2				½R-R-R	mf/2				

5.2.2.3. NIMS General

Six housekeeping measurements will be picked up from contiguous locations in NIMS memory starting at 1592_{hex} and put into the 91-deck of the engineering telemetry. They are S-1924, S-1925, S-1926, S-1927, S-1929, and S-1930.

NIMS Data Flow in CDS



5.2.3. Changes in NIMS Commands

Four new command types defined:

37ETB--Edit Table Load. Load up to 125 bytes. Similar to 37DML

37RT--RealTime mode--specify map/spectrum mode, mirror position

37MB--Mirror position Block for REC modes.

37ETS--Edit Spectra

S/W loads (editing tables) will be needed for switching between RT and REC modes or between different REC data rates.

5.3. PPR

5.3.1. PPR Data Pickup

The LPW pickup for PPR is unchanged at 18 bytes per mf, collected in RTI 5 following a prepare directive in RTI 4, and is also used for LNR and LPU.

The pickup for the PPR burst-to-tape mode BPT is identical to the current LPW pickup--18 bytes per mf, collected in RTI 5 following a prepare directive in RTI 4.

5.3.2. PPR Data Processing in CDS

5.3.2.1. PPR Record/Playback

In all modes which include PPR data except BPT, CDS will pack 14 18-byte raw instrument data sets into one downlink packet. The packet is sent to the PB virtual channel to be made into VCDUs. The time will be included in two situations: the first packet of each set of recorded data, and every 32nd packet.

PPR Non-BPT PB Data

Time inc.	App ID	Size	Seq #	(Time)	Data1	Data2	...	Data 252
1	7	9	7	32	8	8	...	8
	PPR1			R-R-R-mf				

5.3.2.2. PPR Burst to Tape (BPT)

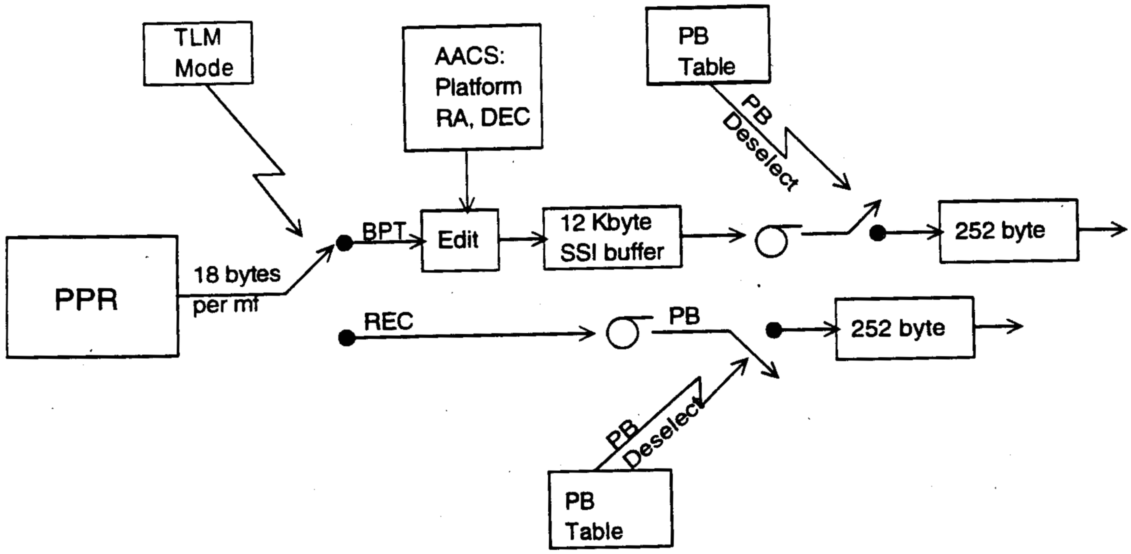
For BPT, the PPR burst-to-tape mode, CDS collects both PPR and AACS data (scan platform RA & Dec) each minor frame. It edits the data before putting it into the buffer by first deleting repeat PPR packets (those with bit 24 set) and the AACS data associated with them, then deleting byte two of the kept instrument data sets, and finally adding a 1-byte mf counter at the beginning of the data set. CDS puts the instrument data and AACS data into about 12 Kbytes of the SSI buffer. When the buffer becomes almost full it is dumped to tape and then starts refilling with no data being lost. The process is repeated as long as the record mode remains BPT. Any data left in the buffer at the end of the BPT mode will be written to the tape.

On playback CDS then packs 10 of the edited 22-byte instrument/AACS/time packets, adds header information, and sends the packet to the PB virtual channel to be made into VCDUs. The time will be included in two situations: the first packet of each burst of data, and each time the sequence number rolls over.

PPR Burst Data (BPT)

Time inc.	App ID	Size	Seq #	(Time)	Data1	Data2	...	Data 220
1	7	9	7	24	8	8	...	8
	PPR2			R-R-R				

PPR Data Flow in CDS



5.3.3. Changes in PPR Commands

None

5.4. EUV

5.4.1. EUV Data Pickup

The EUV RT stream comes from periodic CDS readouts of the instrument's internal 2184-byte buffer. EUV (while it is powered on) is continually summing sensor data into the buffer. CDS periodically reads out the buffer over a period not greater than a RIM, using 24 to 91 transactions. The readout sets occur at intervals of 2639 mf (29 RIMs) when EUV is at its high rate of 10 b/s or 5369 mf (59 RIMs) at 5 b/s. The transactions take place in RTI 1. At the end of the RIM in which the readout occurs CDS tells EUV to zero its buffer by issuing a new 24CLR command.

The EUV REC data pickup remains unchanged from the current 12 bytes per mf in RTI 1. The data are used in LPW whenever EUV is powered on rather than the HIC.

Both the RT and REC data streams are available whenever the instrument is on.

EUV does not take part in RRCC.

5.4.2. EUV Processing in CDS

5.4.2.1. EUV Realtime

CDS processing for the EUV RT data is straightforward, since the data part of the packet is one eighth of the 2184-byte buffer, which is read out as described above, and the only thing to do is add the header information. The time of the start of the summation period is included in the first packet of data from each buffer, and the time of the end of the summation is included in the last packet from the buffer. The mf is not included in either time because the summation always begins and ends on mf 0. The packets are formed into VCDU's in the RT virtual channel.

Whenever a 6TMCHG command including an RT mode is issued, even if it does not involve switching the EUV RT allocation, CDS will wait for the end of the current RIM, read out the buffer, wait for the last mf of the then-current RIM, issue the 24CLR command to tell EUV to zero its buffer, and start a new summation period (possibly for a different rate) at the start of the next RIM.

RT deselect has a special meaning for EUV. When EUV is deselected from RT, CDS will keep counting down to the next time when it would perform a readout but will not perform the readout or issue the 24CLR command. It will perform those actions the next time the clock counts down to zero and RT is selected. It also will not perform a readout at RT telemetry mode changes and will not issue the clear command, but will reset the counter.

CDS keeps track of whether its EUV buffer has been packetized since it was last filled. If it has not been (because of insufficient downlink rate) at the time when it would otherwise be overwritten with new data, CDS will act as if a deselect were active. That is, it will reset the countdown timer but will not perform a readout or tell EUV to zero its internal buffer.

EUV RT Data

Time inc.	App ID	Size	Seq #	(Time)	Data1	Data2	...	Data 273
1	7	9	7	24	8	8	...	8
	EUV1			R-R-R				

5.4.2.2. EUV Record/Playback

No editing is performed on the EUV REC/PB data. The packet is simply standard header information followed by 21 12-byte EUV LPW data sets unless fewer contiguous data sets are available. The time will be included in two situations: the first packet of each set of PB data, and every 16th packet. The packets are formed into VCDU's in the PB virtual channel and the format is:

EUV PB Data

Time inc.	App ID	Size	Seq #	(Time)	Data1	Data2	...	Data≤252
1	7	9	7	32	8	8	...	8
	EUV2			R-R-R-mf				

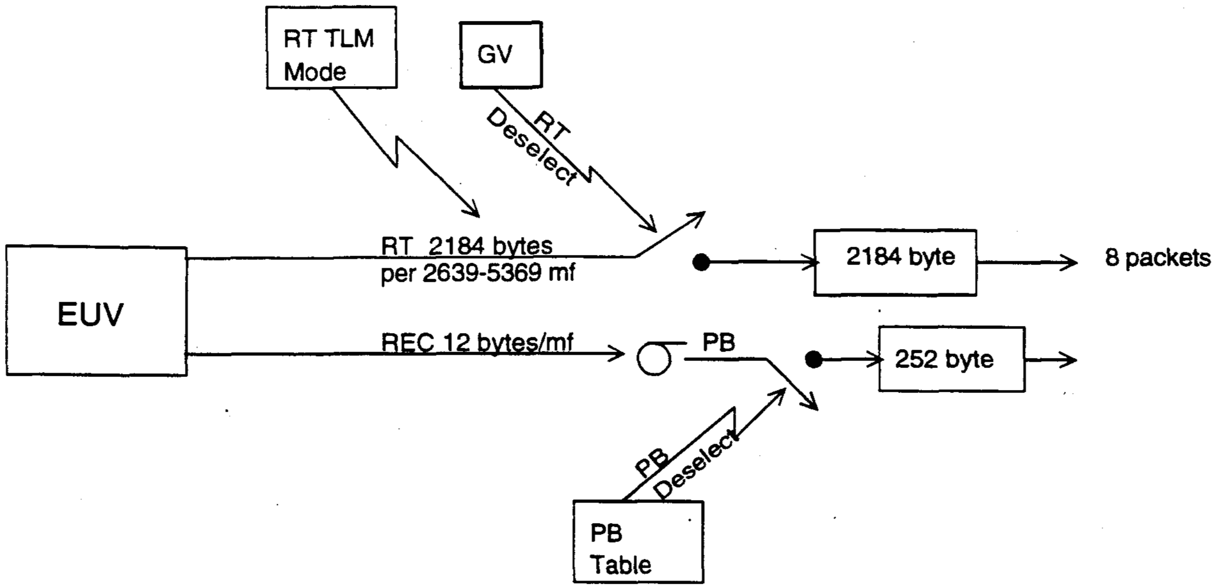
5.4.2.3. EUV General

No EUV RRCC.

There is no commanding needed for switching between RT and REC modes.

There are three engineering channels (E-3429, E-3430, E-3431) which need to be downlinked approximately every ten hours. All instrument housekeeping data are returned in the regular packets.

EUV Data Flow in CDS



5.4.3. Changes in EUV Commands

A new 1-byte 24CLR command with a unique address is being added to tell EUV to zero out its buffer. The 24CLR command will supply a non-zero value to the unique address which will tell EUV to zero the buffer.

Memory loads of 750-1000 bytes are required after power on, with the same timing requirements as current memory loads. The loading will be done from the sequence, and not from CDS memory.

Loading of a "fixed pattern noise table" of approximately 128 bytes may also be required.

5.5. UVS

5.5.1. UVS Data Pickup

The RT pickup for UVS is identical to the current LPW pickup--84 bytes per mf, collected in RTI 3, independent of the UVS RT data allocation.

The LPW pickup for UVS is unchanged at 84 bytes per mf, collected in RTI 3, and the same data are also used for LNR and LPU.

The RRCC pickup for UVS is identical to the current LPW pickup--84 bytes per mf, collected in RTI 3.

The data stream which provides both the RT and REC data is always available whenever the instrument is on.

5.5.2. UVS Data Processing in CDS

5.5.2.1. UVS Realtime

The UVS RT data cycle is 13 mf's, comprising 1092 8-bit measurements at 84 bytes per mf. CDS maintains a 16-bit summation buffer of 2184 bytes and sums the RT data into the buffer (each 8-bit measurement into a unique 16-bit sum) for the period appropriate for the UVS RT data allocation--2639 mf (29 RIMs) for 10 b/s, 5369 mf (59 RIMs) for 5 b/s, or 131040 mf (1440 RIMS) for 0.2 b/s.

At the end of the summation period CDS checks to see whether UVS is deselected from RT. If it is, the clock is reset so that its next timeout is when it would have been without the deselect and summing continues. If not, the summation is paused (at mf=0), the buffer is split into 8 packets and sent to the the RT virtual channel to be made into VCDUs. The buffer is zeroed and summation is resumed (at mf=0) one RIM after it was interrupted, with the summation period based on the then-current UVS allocation. When the downlink rate is not sufficient to handle the RT stream and the multi-use buffer is full at what would be a readout time, CDS will reset the countdown clock and continue to sum the data rather than throwing any away. In other words, a full multi-use buffer is treated like a deselect.

The first mf 0 after a 6TMCHG command with an RT field other than No Change will be treated like the end of a summation period, if UVS RT is selected, with the same test for buffer full, and the same subsequent actions. This is so that there is a way to interrupt the 24-hour summation when an observation needing higher temporal resolution is to begin. If UVS RT is deselected, the 6TMCHG will be ignored and summation will continue.

No instrument commanding is needed when RT rates are changed.

The time of the start of the summation is included in the first packet for each buffer, and the time of the end of the summation is included in the last packet for the buffer. The mf is not included in either time because the summation always begins and ends on mf 0.

UVS RT Data

Time inc.	App ID	Size	Seq #	(Time)	Data1	Data2	...	Data 273
1	7	9	7	24	8	8	...	8
	UVS1			R-R-R				

5.5.2.2. UVS Record/Playback

Each PB packet consists of three 84-byte instrument data sets (if that many with contiguous times are available). The time will be included for the first packet of each set of PB data and every 16th packet. The packets are formed into VCDU's in the PB virtual channel and the format is:

UVS PB Data

Time inc.	App ID	Size	Seq #	(Time)	Data1	Data2	...	Data≤252
1	7	9	7	32	8	8	...	8
	UVS2			R-R-R-mf				

5.5.2.3. UVS RRCC

No editing is performed on the UVS RRCC data. The packet is simply standard header information followed by 5 to 18 84-byte UVS LPW packets (from the up to 12-second RRCC period). The time will be included in each RRCC packet. The packets are formed into VCDU's in the RRCC virtual channel and the format is:

UVS RRCC Data

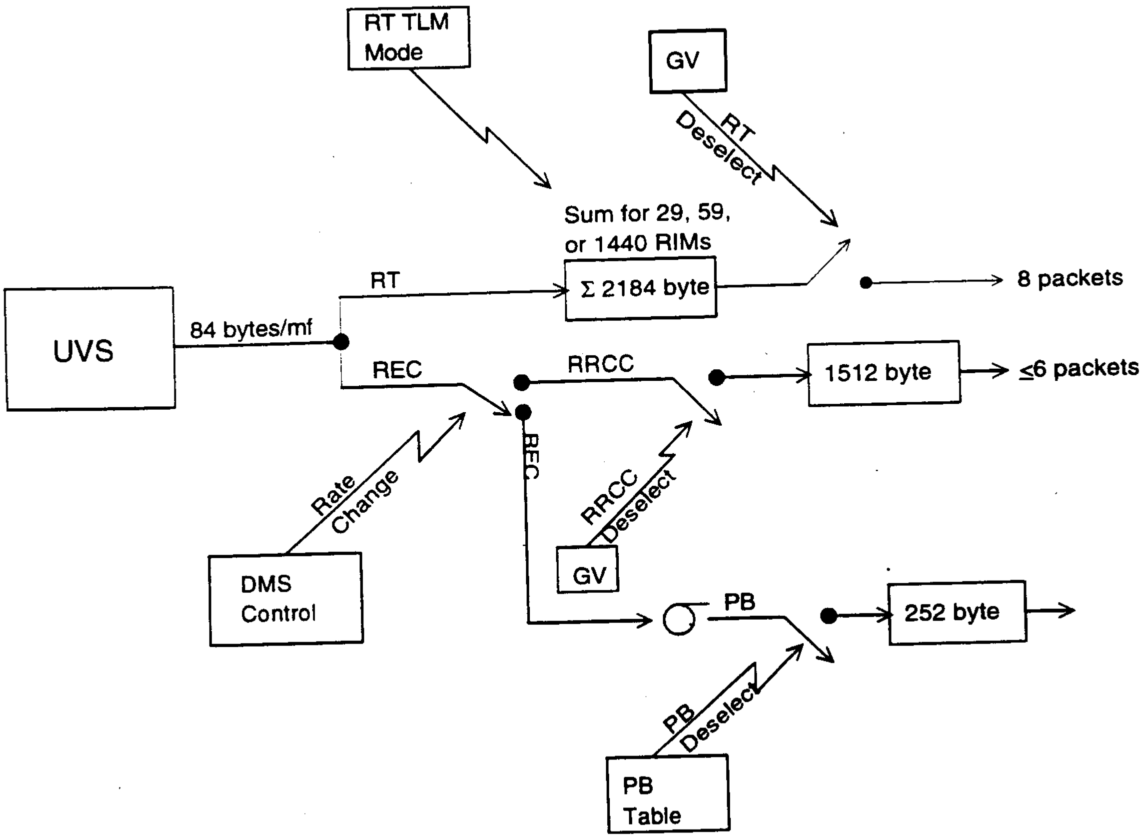
Time inc.	App ID	Size	Seq #	Time	Data1	Data2	...	Data≤252
1	7	9	7	32	8	8	...	8
1	UVS3			R-R-R-mf				

CDS will flush the final VCDU of each RRCC instance with dummy data if necessary.

5.5.2.4. UVS General

All instrument housekeeping data are returned in the regular packets. Temperature measurement E1790 will continue to be returned in the 91 deck.

UVS Data Flow in CDS



5.5.3. Changes in UVS Commands

None.

5.6. MAG

5.6.1. MAG Data Pickup

The MAG RT data pickup is six bytes (a 16-bit time-averaged field strength measurement for each axis) picked up every mf, with CDS keeping only 1-of-n data sets, with the intervals corresponding to RT allocations of 16 to 2 b/s, respectively. The pickup can be in RTI 1, 2, 7, or 8 and prepare directives are not used.

Rate 1 keep interval: 36 mf
Rate 2 keep interval: 18 mf
Rate 3 keep interval: 12 mf
Rate 4 keep interval: 9 mf
Rate 5 keep interval: 6 mf
Rate 6 keep interval: 4 mf

The REC LPW pickup for MAG remains unchanged at 20 bytes per mf, with 10 being picked up in RTI 5 and 10 in RTI 1. The data are always available, and are also used for LNR.

The MAG RRCC mode uses the same data pickup as LPW.

MAG supplies three packet types: RT, REC/PB, and RRCC, in addition to standard instrument MRO.

5.6.2. MAG Data Processing in CDS

5.6.2.1. MAG Realtime

The processing for RT MAG data is a straightforward double buffering into 180-byte buffers, packetization (adding header information), and forming into a VCDU in the RT virtual channel. The Format ID field is used to indicate at which RT rate the data were taken. The time will be included in two situations: the first packet of a new rate and every 16th packet. The packet format is:

MAG RT Data

Time inc.	App ID	Size	Seq #	Fmt ID	(Time)	Data1	Data2	...	Data 90
1	7	9	7	4	28	16	16	...	16
	MAG1				½R-R-R-mf				

When a 6TMCHG command with an RT field other than No Change is issued, CDS will wait until the next scheduled RT pickup, send the two-byte filter setting appropriate for the (possibly new) MAG data allocation to MAG in the same mf in an RTI other than 3-6, and schedule the next RT pickup at the (possibly new) appropriate interval. If the MAG allocation does actually change, CDS will also close out the current packet and begin a new one. If MAG is deselected from the RT data stream, CDS will not issue the two filter setting bytes at the 6TMCHG as described, so that MAG can use its special long-term averaging settings.

5.6.2.2. MAG Record/Playback

No editing is performed on the MAG REC/PB data. The packet is simply standard header information followed by 12 20-byte MAG LPW data sets. The time will be included in two situations: the first packet of each set of PB data and every 32nd packet. The packets go into the PB virtual channel and the format is:

MAG PB Data

Time inc.	App ID	Size	Seq #	(Time)	Data1	Data2	...	Data 120
1	7	9	7	32	16	16	...	16
	MAG2			R-R-R-mf				

5.6.2.3. MAG RRCC

No editing is performed on the MAG RRCC data. The pre-compression and decompressed packet is simply standard header information followed by 5-18 20-byte MAG LPW packets (from the up to 12-second RRCC period). The time will be included in each RRCC packet. The packets are formed into VCDU's in the RRCC virtual channel and the format is:

MAG RRCC Data

Time inc.	App ID	Size	Seq #	Time	Data1	Data2	...	Data≤180
1	7	9	7	32	16	16	...	16
1	MAG3			R-R-R-mf				

5.6.2.4. MAG General

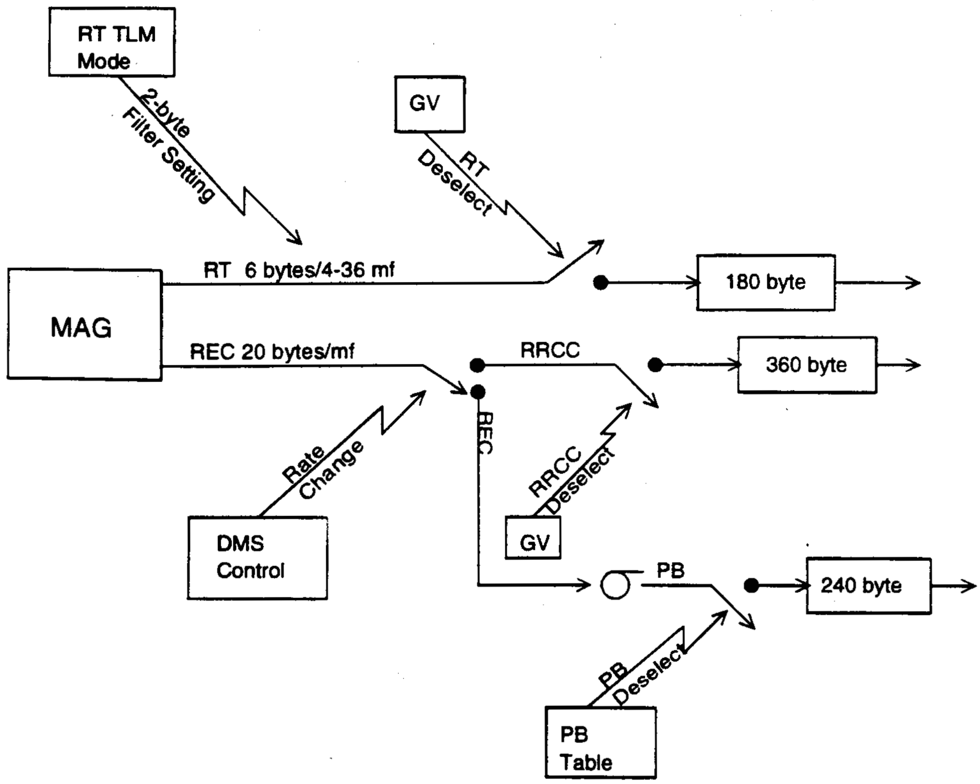
Since both the RT and the REC data streams are available at all times, no commanding is needed fro switching from one to the other.

MAG data can be deselected from either the RT or the PB data streams, and the normal usage will be to continue using the RT data while LPW is being recorded.

Housekeeping data will be returned in recorded LPW and by MRO.

Three 2-byte sensor offsets will be added to the 91-deck of the fixed engineering telemetry.

MAG Data Flow in CDS



5.6.3. Changes in MAG Commands

None.

5.7. DDS

5.7.1. DDS Data Pickup

The DDS RT data pickup is simply a less-frequent version of the LPW DDS pickup, with two bytes of data each 7 or 21 mf's. Like the current DDS REC data, pickup occurs in RTI 5 following a prepare directive in RTI 4. No commanding is required for switching between RT rates or between RT and REC modes.

The LPW pickup for DDS is unchanged at 2 bytes per mf, collected in RTI 5 following a prepare directive in RTI 4, and is also used for LNR.

The RRCC pickup for DDS is identical to the current LPW pickup--2 bytes per mf, collected in RTI 5 following a prepare directive in RTI 4.

5.7.2. DDS Data Processing in CDS

5.7.2.1. DDS Realtime

The DDS RT data cycle is 637 or 1911 mf's (at pickup intervals of 7 or 21 mf's, respectively), comprising 182 bytes of data. The raw packet has header data added and is sent the the RT virtual channel to be made into a VCDU. The Format ID field is used to indicate at which RT rate the data were taken. The time will be included in two situations: the first packet of a new rate and every 8th packet.

DDS RT Data

Time inc.	App ID	Size	Seq #	Fmt ID	(Time)	Data1	Data2	...	Data 182
1	7	9	7	4	28	8	8	...	8
	DDS1				½R-R-R-mf				

When a 6TMCHG command changes DDS's RT rate, CDS will finish the current data cycle (which also completes the packet) and then simply start sending the prepares and picking up the data at the new rate.

5.7.2.2. DDS Record/Playback

No editing is performed on the DDS REC/PB data. The packet is simply standard header information followed by 128 2-byte DDS LPW data sets. The time will be included in two situations: the first packet of each set of PB data and every 8th packet. The packets are formed into VCDU's in the PB virtual channel and the format is:

DDS PB Data

Time inc.	App ID	Size	Seq #	(Time)	Data1	Data2	...	Data 256
1	7	9	7	32	8	8	...	8
	DDS2			R-R-R-mf				

5.7.2.3. DDS RRCC

No editing is performed on the DDS RRCC data. The packet is simply standard header information followed by 5 to 18 2-byte DDS LPW data sets (from the up to 12-second RRCC period). The time will be included in each RRCC packet. The packets are formed into VCDU's in the RRCC virtual channel and the format is:

DDS RRCC Data

Time inc.	App ID	Size	Seq #	Time	Data1	Data2	...	Data≤36
1	7	9	7	32	8	8	...	8
1	DDS3			R-R-R-mf				

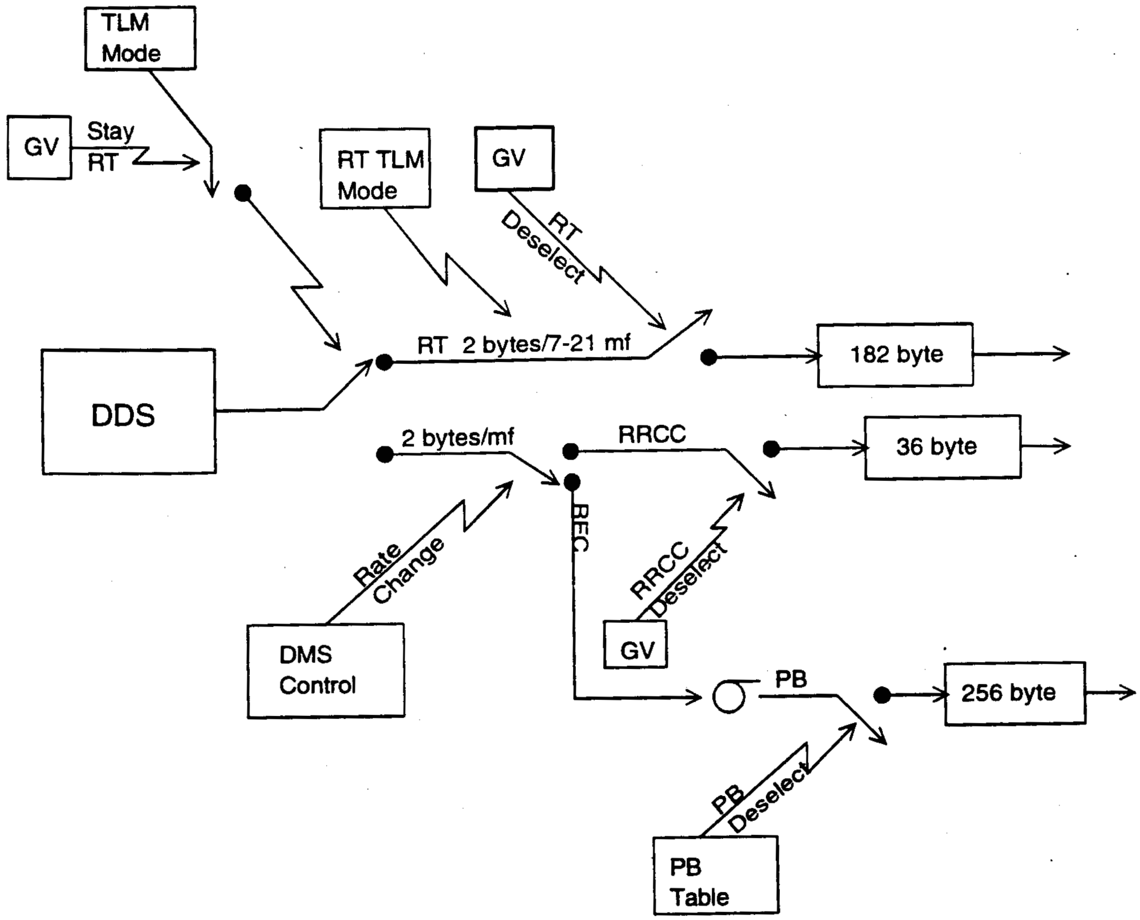
CDS will flush the final VCDU of each RRCC instance with dummy data.

5.7.2.4. DDS General

The commanding for switching between RT and REC modes is under sequence control, with a bit in a global variable telling CDS whether DDS is deselected from a REC mode, in which case the RT stream should continue to be processed.

DDS data can be independently deselected from the RT and PB streams.

DDS Data Flow in CDS



5.7.3. Changes in DDS Commands

No new commands planned. Switching pickup interval (1, 7, 21 mf's) is accomplished simply by sending the prepare directive only when data are going to be read.

5.8. PLS

5.8.1. PLS Data Pickup

The PLS RT pickup is a periodic reading of the instrument's buffer (of approximately 225 bytes), with the read interval being a function of the PLS RT allocation: 5, 10, 15, 20, 30, or 40 b/s. The readout is two pickups of about 115 bytes each in consecutive mf's in RTI 5, following a prepare directive in RTI 4. The prepare and pickup look like an MRO to PLS (the nonstandard RTIs don't matter), while to CDS it is a non-MRO pickup.

The REC LPW data pickup from PLS remains unchanged at 51 bytes per mf, collected in RTI 3 following a prepare command in RTI 2, and is also used for LNR. The pickup and its prepare are done continuously, even when PLS is not in the record mode.

The RRCC data pickup from PLS is identical to the LPW pickup at 51 bytes per mf, collected in RTI 3 following a prepare command in RTI 2.

5.8.2. PLS Data Processing in CDS

5.8.2.1. PLS Realtime

The only processing CDS does to PLS RT data is putting one instrument packet of up to 225 bytes (with the exact length being a function of the instrument mode) together with the standard header information and sending the packet to the RT virtual channel. The Format ID field is used to indicate at which RT rate the data were taken. The time will be included in two situations: the first packet of a new rate and every 16th packet.

PLS RT Data

Time inc.	App ID	Size	Seq #	Fmt ID	(Time)	Data 1	Data 2	...	Data≤225
1	7	9	7	4	28	8	8	...	8
	PLS1				½R-R-R-mf				

When a 6TMCHG command changes PLS's RT rate, CDS will complete the current countdown/readout cycle (filling a packet in the process) and then issue the cmd to PLS for the new rate and will immediately start picking up data at the new rate.

5.8.2.2. PLS Record/Playback

CDS packs together 5 51-byte PLS PB instrument packets, adds header information, and sends the packet to the PB virtual channel to be made into VCDUs. The time will be included in two situations: the first packet of each set of PB data and every 16th packet.

PLS PB Data

Time inc.	App ID	Size	Seq #	(Time)	Data1	Data2	...	Data 255
1	7	9	7	32	8	8	...	8
	PLS2			R-R-R-mf				

5.8.2.3. PLS RRCC

No editing is performed on the PLS RRCC data. The packet is simply standard header information followed by up to 5 51-byte PLS LPW data sets . There are up to 4 packets per RRCC instance, with the time being included in the first RRCC packet of each RRCC occurence and whenever the sequence number rolls over. The packets are formed into VCDU's in the RRCC virtual channel and the format is:

PLS RRCC Data

Time inc.	App ID	Size	Seq #	Time	Data1	Data2	...	Data≤255
1	7	9	7	32	8	8	...	8
	PLS3			R-R-R-mf				

CDS will flush the final VCDU of each RRCC instance with dummy data.

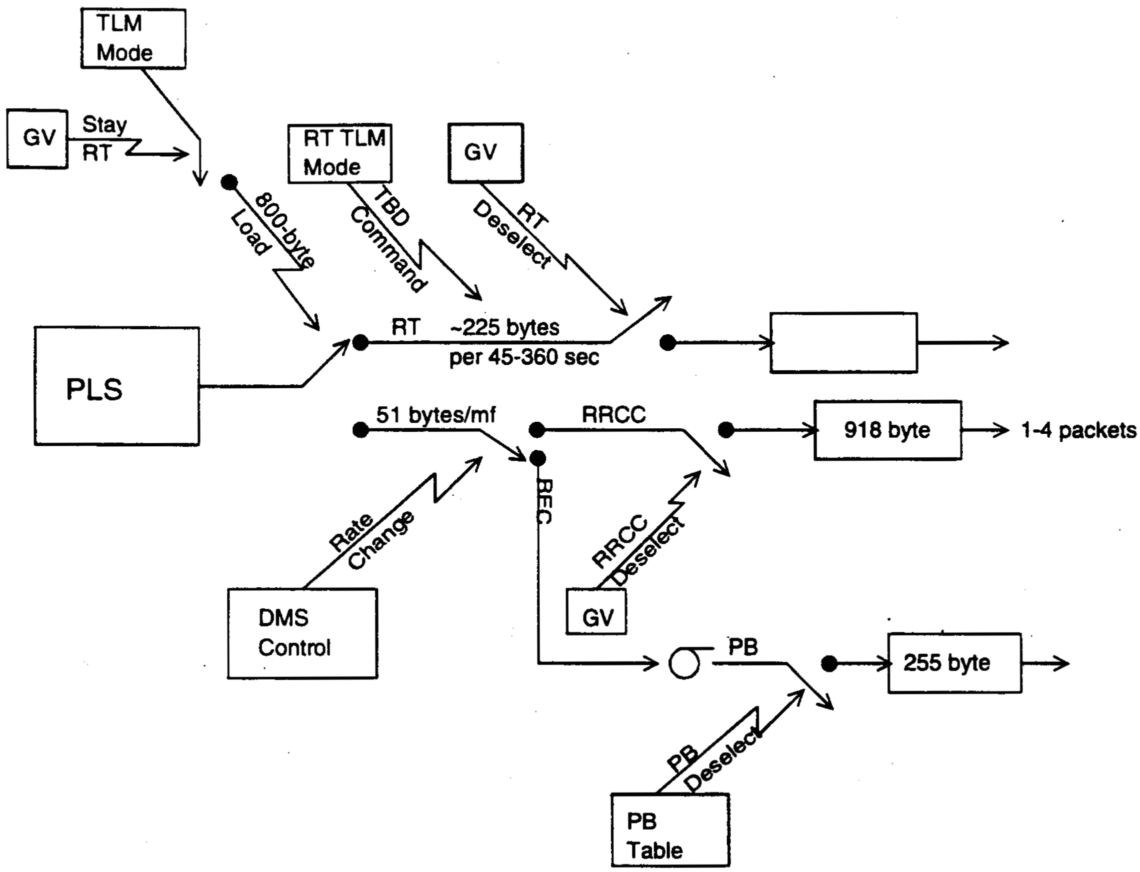
5.8.2.4. PLS General

Commanding (in general from the stored sequence in association with 6TMCHG or possibly a realtime command) is required for switching between RT rates or between RT and REC modes, with a memory load of ~800 bytes needed for the latter switch. The switching process involves disabling certain ongoing instrument processes, loading the PLS code memory, updating the links to point to the newly loaded code, and reenabling the stopped processes. CDS will store sets of 32IDM memory load commands (<255 bytes per set) which the sequence will load into PLS memory using 6MCPY commands. The disable, load, and enable sets of commands will be in separate mf's so that PLS can act on them before the next set is loaded.

The commanding and memory loading for switching between RT and REC modes is under sequence control, with a bit in a global variable telling CDS whether PLS is deselected from a REC mode, in which case the RT stream should continue to be processed. PLS data can also be deselected from the RT stream.

All housekeeping data come from the REC/PB data unless there is an instrument anomaly, in which case MRO's will be used.

PLS Data Flow in CDS



5.8.3. Changes in PLS Commands

New functionality will be implemented by defining pseudonyms of the existing 32IDM command for the memory loads used for switching between RTS and LPW modes, and between different RTS rates.

5.9. PWS High-Rate

5.9.1. PWS High-Rate Data Pickup

There are no RT PWS high-rate modes, although dual-use modes MPW, MPP, and HPW are being kept as REC modes, and PWS data will be used as filler data whenever the downlink rate exceeds the RT rate and PB data are not available or frames of fill data are being used for DSN lockup.

Existing REC modes: PWS supplies data at 2.592 kb/s for LPW, 7.68 kb/s for MPW, 19.2 kb/s for MPP, and 94.56 kb/s for HPW.

5.9.2. PWS High-Rate Data Processing in CDS

5.9.2.1. PWS Fill Data

PWS fill data is taken from the PWS LPW buffer . The data portion of the packet is in the same format as the LPW data but is 4 bytes longer. CDS assembles the fill data from the most recently commanded instrument mode. The PWS fill packets are turned into VCDUs in the RT virtual channel. The time will be included in all packets. CDS will always have 2 VCDUs of fill data available for use either to fill in when normal downlink is enabled but no other data are available, or to be sent in "dummy" telemetry frames used to allow a DSN station without an FSR to lockup on the signal initially or after a phase/frequency shift.

PWS Fill Data

Time inc.	App ID	Size	Seq #	Time	Data1	Data2	...	Data 436
1	7	9	7	32	8	8	...	8
1	PWH1			R-R-R-mf				

5.9.2.2. PWS High-Rate Record/Playback

CDS processing of PWS high-rate PB data is a 1-of-*n*-line editor (which merely skips *n*-1 RTIs of data after each RTI read for modes other than LPW, for which a line of 432 bytes is the data from two consecutive mf's, starting with an even-numbered one). The value of *n* can range from 1 to 16. The packets are sent to the PB virtual channel to be made into VCDUs. The Format ID field is used to indicate at which rate the data were taken and the value of *n*. The time will be included in two situations: the first packet of each set of PB data and every 32nd packet.

REC Mode	PWS Bytes per Frame	Frames per Packet
LPW	216	1
MPW	64	4
MPP	160	2
HPW	788	½

PWS High-rate PB Data

Time inc.	App ID	Size	Seq #	Fmt ID	(Time)	Data1	Data2	...	Data≤394
1	7	9	7	8	32	8	8	...	8
	PWH2				R-R-R-mf				

5.9.2.3. PWS Golay Replacement Data

CDS processing of the PWS high-rate used to replace the Golay code (making the old LRS into the new LPW) also uses the 1-of-n-line editor and deselect processes as explained above. The Format ID field uses its high--order bit to tell which half-line the packet represents, with the low nybble giving the n value used in editing. The packets are sent to the PB virtual channel to be made into VCDUs. The time will be included in two situations: the first packet of each set of PB data and every 16th packet.

PWS LPW Golay Replacement Data

Time inc.	App ID	Size	Seq #	Fmt ID	(Time)	Data1	Data2	...	Data ≤216
1	7	9	7	8	32	8	8	...	8
	PWH3				R-R-R-mf				

5.9.2.4. PWS Golay Replacement RRCC

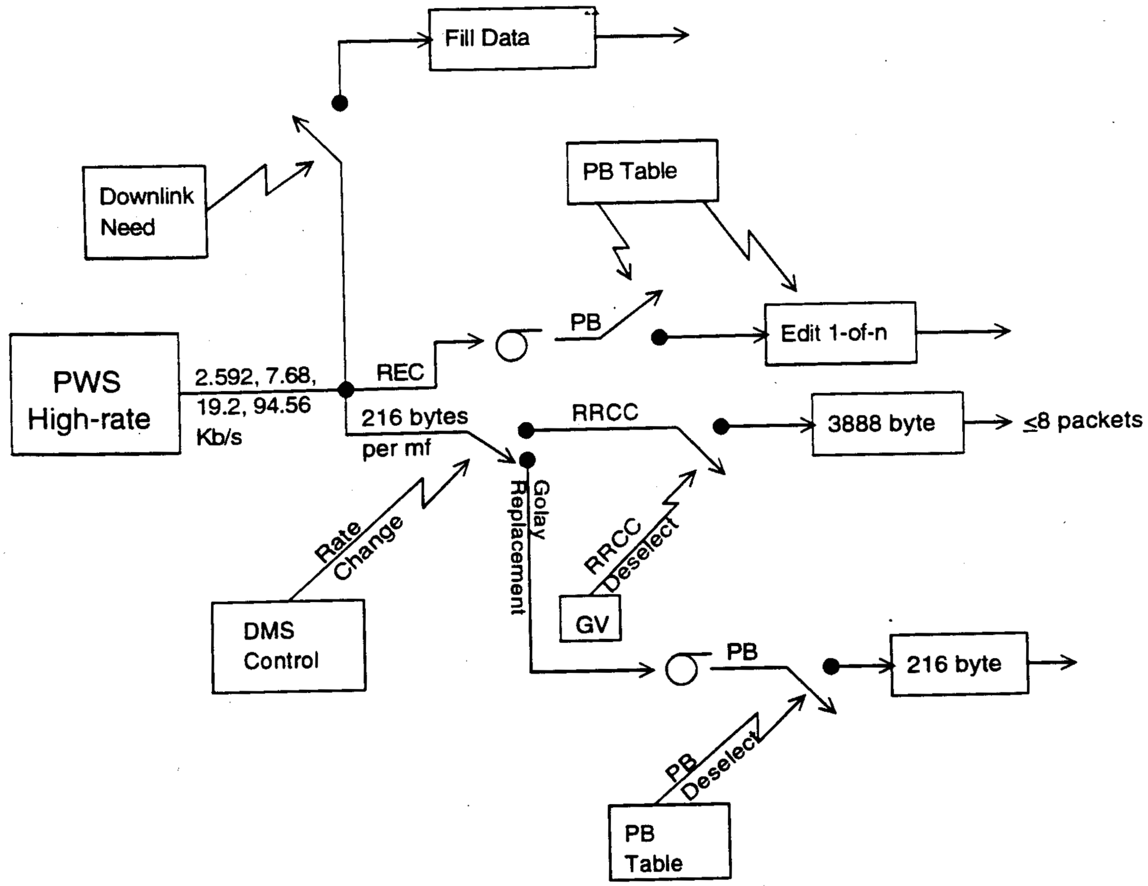
Each packet contains data from one mf of LPW data. Time is included in the first packet of each RRCC instance, as well as whenever the sequence number rolls over.

PWS LPW Golay Replacement RRCC Data

Time inc.	App ID	Size	Seq #	Fmt ID	(Time)	Data1	Data2	...	Data 216
1	7	9	7	8	32	8	8	...	8
	PWH4				R-R-R-mf				

CDS will flush the final VCDU of each RRCC instance with dummy data.

PWS High-rate Data Flow in CDS



5.10. PWS Low-Rate

5.10.1. PWS Low--Rate Data Pickup

The RT pickup for PWS low-rate data is identical to the current LPW pickup, at 20 bytes per mf in RTI 1 with no prepare command used.

The REC LPW pickup for PWS low-rate data is identical to the current LRS pickup, at 20 bytes per mf in RTI 1 with no prepare command, ans is also used for LNR.

The RRCC pickup for PWS low-rate data is identical to the current LPW pickup, at 20 bytes per mf in RTI 1 with no prepare command used.

5.10.2. PWS Low-Rate Data Processing in CDS

5.10.2.1. PWS Low-Rate Realtime

The RT PWS data are edited, rearranged, and sent through an 8x8 ICT compression in AACS at one of 6 commandable target compression ratios, giving effective post-compression data rates of 5, 10, 15, 20, 30, and 40 b/s. Details elsewhere. The time will be included in two situations: the first packet of a new rate and every 32nd packet. The PWS packets are turned into VCDUs in the RT virtual channel.

Over 28 mf's CDS builds up one line of 152 measurements. When 8 lines have been built up, creating a compression frame of 1216 bytes, the ICT is started.

The level of compression achieved depends on both the data being compressed and the Q factor fed into the ICT algorithm. The high degree of data sensitivity means that if a Q factor is chosen which guarantees a bit rate not greater than the allocation, much of the time the bit rate will be far below the allocation, resulting in less useful data. To avoid this undesirable situation the compression is dynamic.That is, the Q factor is adjusted one step up or down based on the compression performance. Each data rate has a fixed predefined range around it in which the compression is considered acceptable. Compression results outside this range will result in the Q factor being changed for a fixed number of compression frames covering a time interval of 5 to 30 RIMs.

The data from the ICT consists of a strip of 152 8x8 blocks. Each block of data consists of Huffman codes from the 8x8 region followed by a 1-bit flag which is set to 1 if the attempted compression resulted in expansion. In the case of expansion, the data returned are truncated at 64 bytes,. The data from the compression blocks within each strip are packed into bytes with no gaps, but with up to 7 bits of zero fill after the last block in the strip. The data field can be split across packet boundaries, but the sync code can not.

There is a global variable bit which tells the ICT handler whether or not to use the compression rate specified by the RT part of the telemetry mode. If the bit is set, the Q factor which determines the target level of compression comes from the 5 b/s mode, rather than from the commanded RT mode. When the PWS RT data allocation changes, CDS will finish the current packet before switching to the new Q factor, if the global variable indicates that the RT telemetry mode determines Q.

The Format ID field is used to indicate which Q value was used to compress the data.

PWS Low-rate RT Data

Time inc.	App ID	Size	Seq #	Fmt ID	(Time)	Data1	Data2	...	Data≤256
1	7	9	7	4	28	8	8	...	8
	PWL1				½R-R-R-mf				

5.10.2.2. PWS Low-Rate Record/Playback

The CDS performs no processing on PB PWS low-rate data except blocking 12 20-byte instrument packets together, adding the standard header information, and sending to the PB virtual channel to be made into VCDUs. The time will be included in two situations: the first packet of each set of PB data and every 32nd packet. This data stream contains all the housekeeping data needed by the PWS team.

PWS Low-rate PB Data

Time inc.	App ID	Size	Seq #	(Time)	Data1	Data2	...	Data≤240
1	7	9	7	32	8	8	...	8
	PWL2			R-R-R-mf				

5.10.2.3. PWS Low-Rate RRCC

No editing is performed on the PWS RRCC data. The packet is simply standard header information followed by 5 to 18 20-byte PWS LPW packets (from the up to 12-second RRCC period). The time will be included in each RRCC packet. The packets are formed into VCDU's in the RRCC virtual channel and the format is:

PWS RRCC Data

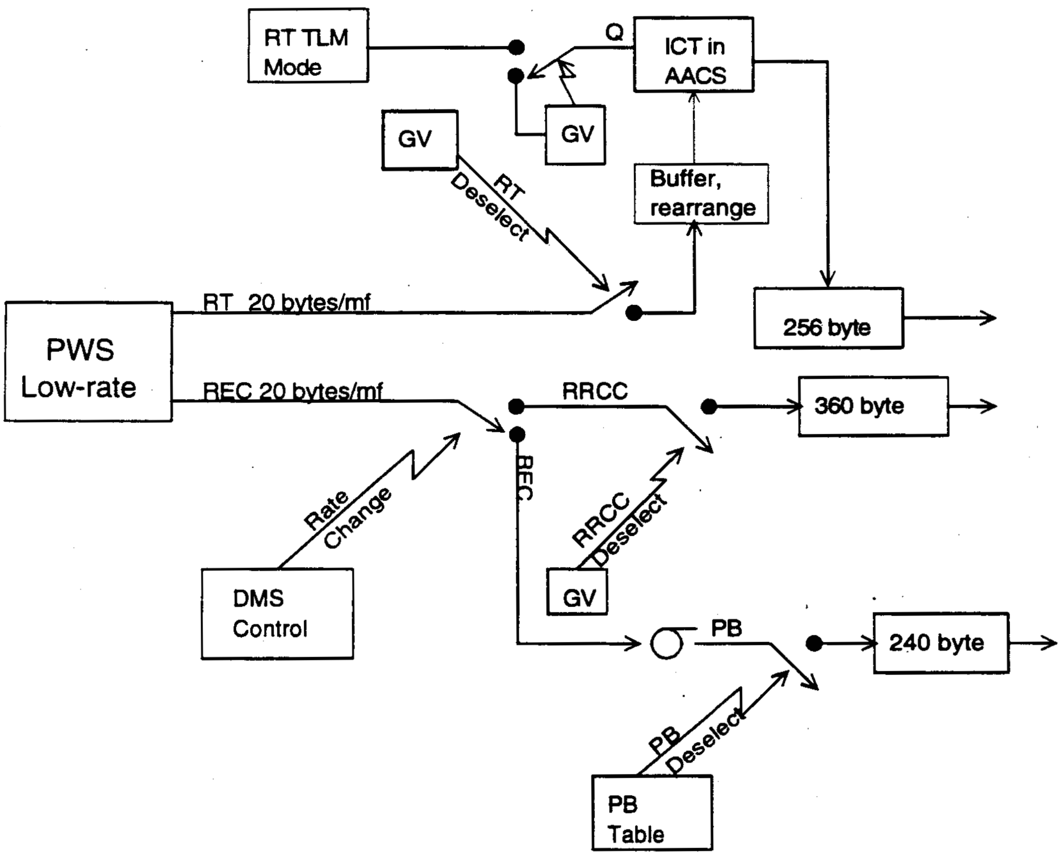
Time inc.	App ID	Size	Seq #	(Time)	Data1	Data2	...	Data≤360
1	7	9	7	32	8	8	...	8
	PWL3			R-R-R-mf				

CDS will flush the final VCDU of each RRCC instance with dummy data.

5.10.2.4. PWS Low-Rate General

PWS data can be independently deselected from the RT and PB data streams. Normal instrument usage will be to keep processing the RT data even when LPW is being recorded.

PWS Low-rate Data Flow in CDS



5.11. EPD

5.11.1. EPD Data Pickup

EPD supplies 145 bytes of RT rate data each mf. CDS will read the data in two transactions in RTI 3.

EPD supplies ≤ 127 bytes of PHA and housekeeping data on command from CDS at intervals ranging from 6 to 72 S/C spins, read in RTI 3.

The REC LPW data pickup from EPD remains unchanged at 76 bytes per mf, collected in RTI 5 with no prepare command, and is also used for LNR.

The RRCC data pickup from EPD is identical to the LPW pickup at 76 bytes per mf, collected in RTI 5 with no prepare command.

5.11.2. EPD Processing in CDS

5.11.2.1. EPD Realtime

The processing for EPD RT data is involved. The 145-byte data sets consist of a 1-byte rate channel header followed by 48 24-bit measurements. Many of the 145-byte data sets will contain repeats of data which have already been processed and will be ignored by CDS. They are marked by having the MSB of the header set to zero. The header format is given below:

MSB							LSB
old/new	SP1	SP2			M1	M2	M3

where SP1-SP2 give the spin quadrant and M1-M3 give the motor position.

Each of the 48 measurements in the non-repeat data sets will be summed into 32-bit "bins," based on a moderately complicated algorithm. The six different EPD RT data allocations specify both the summation period and which of the two Channel Maps to use. The channel maps assign each of the 48 channels to the High-resolution, the Low-resolution, or the Omni-resolution category. Finally, the resolution category specifies how the spin quadrant and motor position are used to determine the binning. For example, channels which are Omni have only two bins, and the others have 7 and 15.

The summation is for a science record of 1 to 6 data cycles, each of which is 7 S/C revolutions (one revolution at each motor position). The number of spins comprising a science record is determined by the RT data allocation. CDS is aided in counting spins by a **TBD** flag in the EPD data, probably in the rate data header byte, indicating the start (or the end, whichever works better) of a spin. When the summation is completed, the bins are log-compressed and packetized.

At the end of each science record, CDS sends a **TBD** command to EPD requesting a set of **TBD** (up to 127) bytes of PHA and housekeeping data.

The Format ID field is used to indicate at which RT rate the data were taken. The time will be included in two situations: the first packet of a new rate and every 16th packet.

EPD RT Data

Time inc.	App ID	Size	Seq #	Fmt ID	(Time)	Data 1	Data2	...	Data≤256
1	7	9	7	4	28	8	8	...	8
	EPD1				½R-R-R-mf				

5.11.2.2. EPD Record/Playback

CDS packs together 3 76-byte EPD PB instrument packets, adds header information, and sends the packet to the PB virtual channel to be made into VCDUs. The time will be included in two situations: the first packet of each set of PB data and every 16th packet.

EPD PB Data

Time inc.	App ID	Size	Seq #	(Time)	Data1	Data2	...	Data 228
1	7	9	7	32	8	8	...	8
	EPD2			R-R-R-mf				

5.11.2.3. EPD RRCC

No editing is performed on the EPD RRCC data. The packet is simply standard header information followed by up to 3 76-byte EPD LPW packets (from the up to 12-second RRCC period). The time will be included in each RRCC packet. The packets are formed into VCDU's in the RRCC virtual channel and the format is:

EPD RRCC Data

Time inc.	App ID	Size	Seq #	Time	Data1	Data2	...	Data≤228
1	7	9	7	32	8	8	...	8
	EPD3			R-R-R-mf				

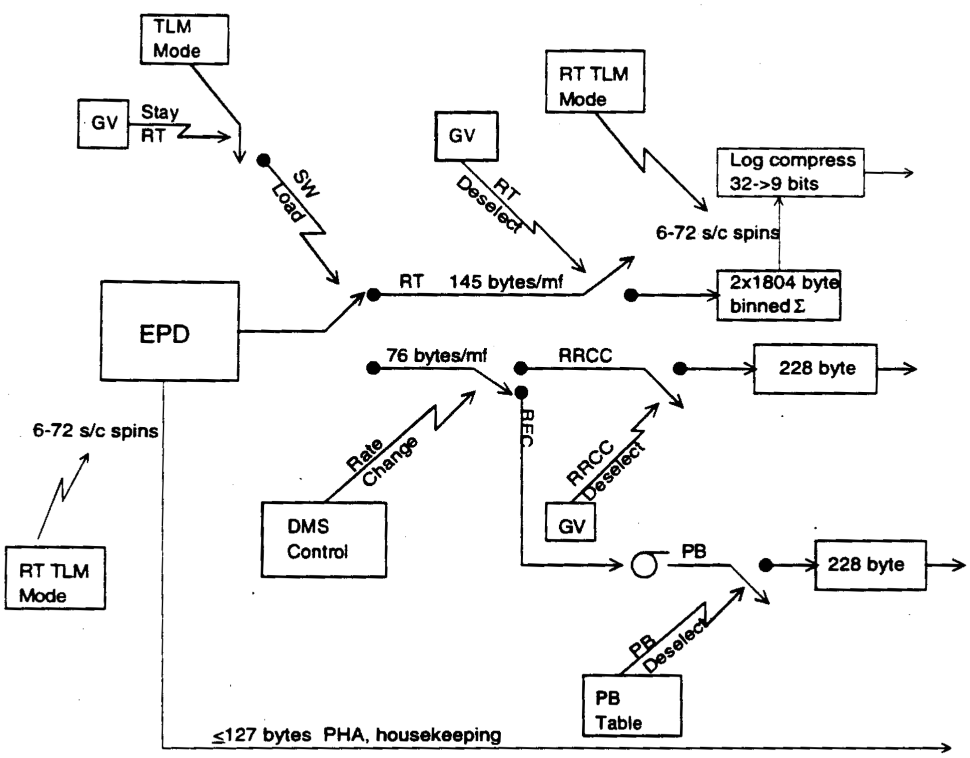
CDS will flush the final VCDU of each RRCC instance with dummy data.

5.11.2.4. EPD General

The commanding for switching between RT and REC modes (about 39 bytes of pointers), including the instrument s/w load, is under sequence control, with a bit in a global variable telling CDS whether EPD is deselected from a REC mode, in which case the RT stream should continue to be processed. When a 6TMCHG command changes EPD's RT rate, CDS will finish the current science record, and then switch the summation period to the one appropriate for the new rate.

CDS delivers sector data to EPD so that the instrument can de-spin its data.

EPD Data Flow in CDS



5.11.3. Changes in EPD Commands

A new command is being added for CDS to tell EPD to prepare the block of PHA and housekeeping data.

Sets of pointers will have to be loaded to switch between RT and REC modes (~39 bytes).

5.12. HIC

5.12.1. HIC Data Pickup

The pickup for the HIC RT mode is identical to the LPW pickup--only the CDS processing is different. Commanding (in general from the stored sequence in association with 6TMCHG or possibly a realtime command) is required for switching between RT rates or between RT and REC modes.

The HIC REC LPW data pick up remains unchanged from the current 12 bytes per mf in RTI 1, and is used whenever HIC is powered on rather than EUV.

The HIC RRCC mode uses the same data pickup as LPW.

5.12.2. HIC Data Processing in CDS

5.12.2.1. HIC Realtime

The format of the HIC RT packet is shown below, with all data being in 12-bit trinybbles.

1st Rate Area	1st Tag Word	1st PHA Area	1st CRC Word	2nd Rate Area	2nd Tag Word	2nd PHA Area	2nd CRC Word	3rd Rate Area	Status Word	3rd Tag Word	3rd PHA Area	3rd CRC Word
36	12	36	12	36	12	36	12	24	12	12	36	12

The 8 rate channel measurements are decompressed, summed, and recompressed. PHA areas which are all zero are deleted, along with their associated tag words. A complete set of the subcommutated status word is saved for downlink about once per hour. The CRC words are thrown away.

The packetizer uses the Format ID to differentiate among the rate data, PHA data, and status data, as well as to indicate the RT rate at which the data were taken.

Each type of raw packet has header data added and is sent the the RT virtual channel to be made into a VCDU. The time will be included in two situations: the first packet of a new rate and every 4th packet.

HIC RT Data

Time inc.	App ID	Size	Seq #	Fmt ID	(Time)	Data1	Data 2	...	Data~252
1	7	9	7	4	28	8	8	...	8
	HIC1				½R-R-R-mf				

5.12.2.2. HIC Record/Playback

HIC PB Data

Time inc.	App ID	Size	Seq #	(Time)	Data 1	Data2	...	Data 240
1	7	9	7	32	8	8	...	8
	HIC2			R-R-R-mf				

5.12.2.3. HIC RRCC

HIC RRCC Data

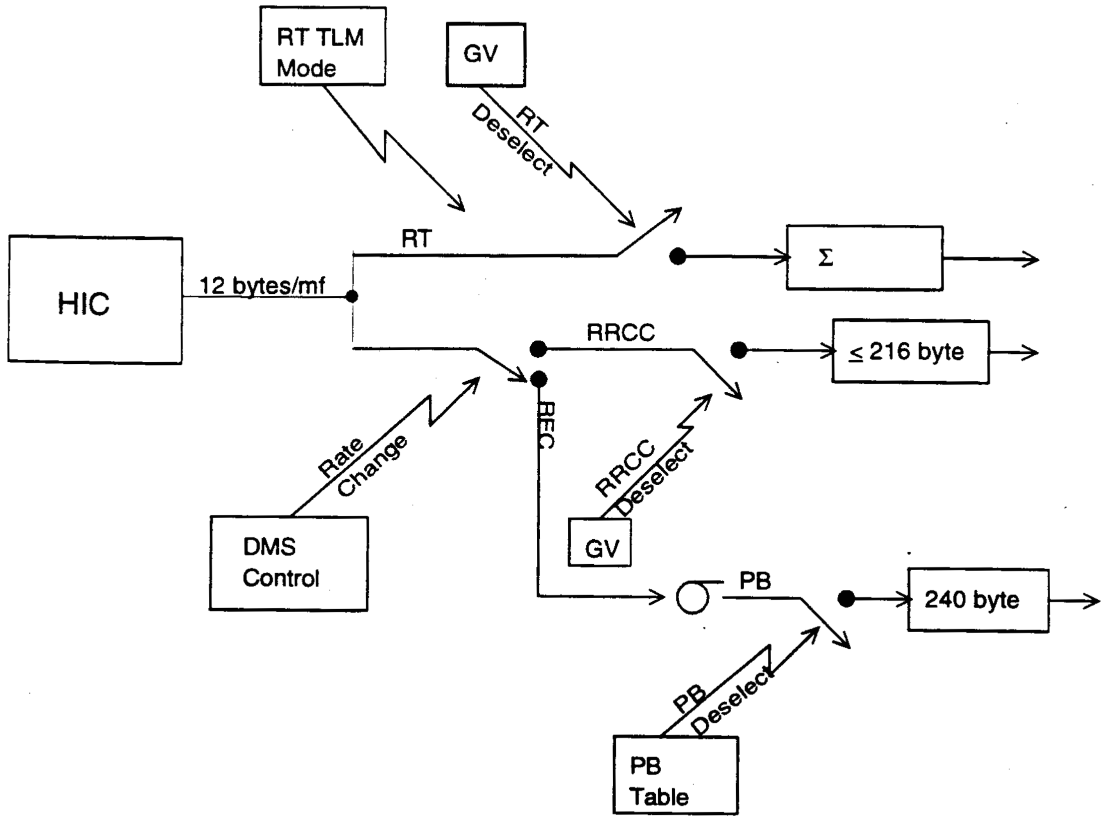
Time inc.	App ID	Size	Seq #	Fmt ID	(Time)	Data1	Data2	...	Data **TBD**
1	7	9	7	4	28	8	8	...	8
	HIC3				½R-R-R-mf				

CDS will flush the final VCDU of each RRCC instance with dummy data.

5.12.2.4. HIC General

The commanding for switching between RT and REC modes is under sequence control, with a bit in a global variable telling CDS whether HIC is deselected from a REC mode, in which case the RT stream should continue to be processed. When a 6TMCHG command changes HIC's RT rate, CDS will finish processing the current instrument data cycle, issue the cmd to HIC for the new rate and will immediately start picking up data at the new rate.

HIC Data Flow in CDS



5.12.3. Changes in HIC Commands

None.

5.13. AACS

All AACS packets, RT, PB, and RRCC, include six measurements: scan platform RA, DEC, and TWIST, and rotor RA, DEC, and TWIST.

The RT packet also includes spin rate, giving 14 bytes per measurement set.

AACS RT data are sampled the first mf of every fifth RIM. Time is included every 32nd packet.

5.13.1. AACS Realtime

AACS RT

Time inc.	App ID	Size	Seq #	(Time)	Data1	Data2	...	Data 252
1	7	9	7	24	8	8	...	8
	AACS1			R-R-R				

5.13.2. AACS Record/Playback

Since there is no AACS PB editor, the recorded AACS data are returned from all mf's unless deselected. The PB and RRCC packets include, in addition to the 6 measurements listed above, a two-byte time tag (R-mf) as thr first two bytes of each measurement set, giving 14 bytes per measurement set. The time field is included every packet.

AACS PB

Time inc.	App ID	Size	Seq #	(Time)	Data1	Data2	...	Data 252
1	7	9	7	24	8	8	...	8
	AACS2			R-R-R				

5.13.3. AACS RRCC

AACS RRCC

Time inc.	App ID	Size	Seq #	Time	Data1	Data2	...	Data≤252
1	7	9	7	24	8	8	...	8
1	AACS3			R-R-R				

5.14. Engineering

5.14.1. Engineering Realtime

The CDS processing of engineering data consists of stripping the 12-byte header from the raw packet, and packing together 4 of the resulting 88-byte data sets (87 data bytes and one spare), each of which is preceded by an Engineering Format Identifier byte specified below:

EFI:
MSB LSB

R2	R1	MRO	CMI2	CMI1	MSN3	MSN2	MSN1

where the RT rate is given by:

R2	R1	Rate, b/s
0	0	2
0	1	10
1	0	40
1	1	1200

and MRO, if set to 1, indicates that the packet includes 32 bytes of MRO data. The two CMI bits are the Commutation Map Identifier, and the three MSN bits are the Map Sequence Number

Time is included every n^{th} packet, where n is given below:

RT Eng. Rate, b/s	*n*
2	4
10	8
40	32

RT Engineering

Time inc.	App ID	Size	Seq #	(Time)	Data1	Data2	...	Data 356
1	7	9	7	32	8	8	...	8
	ENG1			R-R-R-mf				

5.14.2. Engineering Record/Playback

The only processing done to the engineering data on playback is stripping the 12-byte header and packing 4 of the 88-byte data sets together with their respective EFI bytes as defined above. Time is included in each packet.

Engineering PB

Time inc.	App ID	Size	Seq #	Time	Data1	Data2	...	Data 356
1	7	9	7	32	8	8	...	8
1	ENG2			R-R-R-mf				

PD 625-205

Galileo

LEVEL 3 TELEMETRY MEASUREMENTS AND DATA FORMATS, GLL 3-280

PHASE II

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Rev --

4 November, 1993

Table of Contents

3. Telemetry, 3-280

This document establishes the downlink telemetry and data formats for the Galileo Phase II mission. Included are the changes from the baseline mission requirements (deletions and modifications) and the new requirements to support the Phase II mission design.

This document, in conjunction with the following documents constitute the spacecraft Level III requirements for Phase II :

3-100:	Spacecraft Requirements
3-270:	Data System Intercommunications Requirements
3-290:	Command Structure and Assignments
3-300:	Telecommunications
3-310:	Flight Software Requirements

3.1. Overview

The addition of packetized telemetry drives many modifications to the system. The underlying data sampling structure remains intact, but the data formatting and packaging is extensively modified. Data rates that are unsupportable are deleted and additional downlink rates are added. Additional sample rates for engineering data are added and additional record rates are added for special record formats. However, for System Fault Protection and anomaly resolution, engineering TDM modes are retained.

3.2. Downlink Rates

Rate refers to the CDS bit rate prior to software convolutional code (11,1/2) and hardware convolutional code (7,1/2) being applied. Downlink symbol rate is 4 times greater.

3.2.1. Deleted Rates

Reqt. A: Delete the 8 and 16 bps engineering TDM rates.

Comment: The 8 and 16 bit TDM rates were added to support the Phase I mission. For the Phase II mission, TDM modes will be used for anomaly investigation, System Fault Protection and ground testing. For these uses, the 10 bps, 40 bps and 1200 bps (ground only) modes are sufficient.

3.2.2. New Telemetry Modes/Retained TDM Rates

Reqt. A: Provide 90 new packetized telemetry modes as shown in Table 3.2.2.1.

Comment: A telemetry mode is defined as a set of raw data collection rates from the RTS instruments, their associated editing algorithms, the RTE collection rate, and total downlink telemetry rate. RTS instrument and RTE data can be independently deselected, lowering the data collection rates shown (see 3.7.2.3.1 and 3.7.2.4.1).

Reqt. B: Downlink telemetry rates will be 0, 8, 20, 32, 40, 60, 80, 120 and 160 bps.

Reqt. C: Provide for the retention and selection of the 10 and 40 bps engineering Time Division Multiplexed (TDM) telemetry modes.

RTE	RTS	Collection Rate*		DOWNLINK TELEMETRY RATE (bps)								
bps	format	w/HIC	w/EUV	0	8	20	32	40	60	80	120	160
2	A	25.0			AL1	AL2	AL3	AL4	AL5	AL6	AL7	AL8
2	B	26.1		BL0		BL2	BL3	BL4	BL5	BL6	BL7	
2	C	37.9	37.9		CL1	CL2	CL3	CL4	CL5	CL6	CL7	CL8
2	D	40.2	49.5			DL2	DL3	DL4	DL5	DL6	DL7	
2	E	71.6	80.9	EL0	EL1	EL2	EL3	EL4	EL5	EL6	EL7	EL8
2	F	79.8			FL1	FL2	FL3	FL4	FL5	FL6	FL7	FL8
2	G	108.9	108.9			GL2	GL3	GL4	GL5	GL6	GL7	GL8
2	H	139.1				HL2		HL4	HL5	HL6	HL7	HL8
2	I	178.7					IL3		IL5	IL6	IL7	IL8
10	A	33.2			AH1	AH2	AH3	AH4	AH5	AH6	AH7	AH8
10	B	34.4		BH0								
10	C	46.2	46.2		CH1	CH2	CH3	CH4	CH5	CH6	CH7	CH8
10	D	48.5	57.8									
10	E	79.9	89.2			EH2	EH3	EH4	EH5	EH6	EH7	EH8
10	F	88.1										
10	G	117.1	117.1									
10	H	147.4										
10	I	187.0										
40	B	65.5						BA4		BA6		

* Collection Rate is effective rate after R/S encoding plus packet overhead
Modes below heavy line (within RTE rate) fill buffer, modes above line empty buffer.
Deselecting engineering or RTS instruments will lower collection rate and shift lines.

TABLE 3.2.2.1 - Telemetry Modes

3.3. Downlink Frame

Reqt. A: The downlink telemetry frame will be composed of a 2040 byte data section with an 8 byte header (sync word). The data section will be composed of four (4) Reed-Solomon encoded Virtual Channel Data Units (VCDUs) as described in section 3.5. The general structure of the telemetry frame is illustrated in Figure 3.3.1.

Comment: Two bytes will remain unassigned in the frame. They will be filled with fixed pattern data and will appear as the first two bytes of the data field at the beginning of the frame .

PN/SYNC WORD	FOUR VCDUs
8 BYTES	REED-SOLOMON ENCODED DATA FIELD (2040 BYTES)

Figure 3.3.1 - Telemetry Frame Structure

3.4. Telemetry Coding

Coding is applied to the downlink telemetry to decrease the Bit Error Rate (BER) and increase link margin at a given data transmission rate. Interleaving of the data is used to decrease susceptibility to burst noise and Reed Solomon encoding will be used to provide an inner code for Error Detection And Correction (EDAC).

3.4.1. Reed Solomon Coding

Reqt. A: The data section of the downlink telemetry frame, consisting of four VCDUs, will be Reed Solomon encoded.

Reqt. B: The Reed Solomon parity symbols will be interleaved to a depth of eight.

Reqt. C: The downlink telemetry frame will be comprised of eight code words having a variable redundancy to level four. The level 4 code words are: (255, 161), (255, 195), (255, 225), (255,245).

Comment: Figure 3.4.1.1 and Appendix B presents the data fill and ordering for the R/S encoding and Convolutional coding.

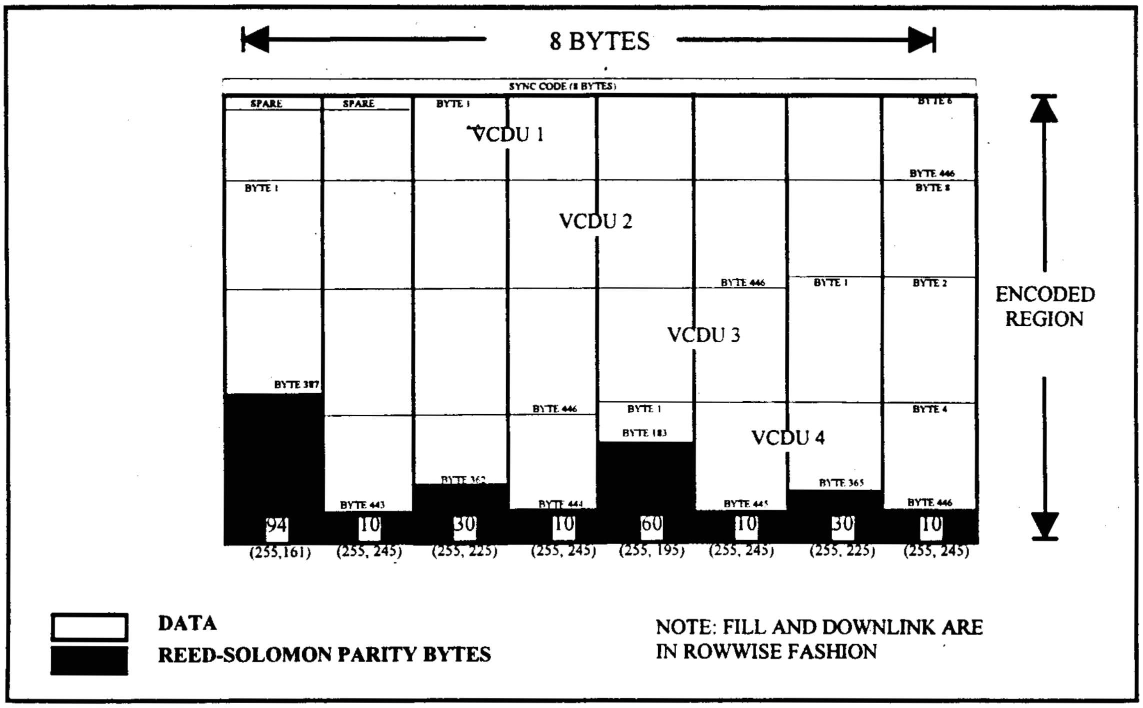

Figure 3.4.1.1 - Reed-Solomon Encoded Words

3.4.2. Convolutional Coding

Convolutional coding is the outer Error Detection And Correction (EDAC) code applied to the downlink data. The Convolutional code is applied in two steps: the CDS applies a (11,1/2) code (which is implemented in software) to the data prior to the data being forwarded to the MDS, which applies a (7,1/2) convolutional code, which is implemented in hardware. The net effect of the two coding steps is a resulting (14,1/4) convolutional code.

3.4.2.1. Software Convolutional Code

Reqt. A: The CDS will be able to encode the transport frame with a (11,1/2) convolutional code implemented in software prior to making it available to the Modulator/Demodulator Subsystem (MDS).

Comment: Since the data are sent to a (7,1/2) hardware convolutional encoder in the MDS, this results in a combined (14,1/4) code.

3.4.3 Golay Coding

Golay coding is an Error Detection And Correction (EDAC) code applied to certain data types to meet tighter Bit Error Rate (BER) requirements. For Phase II, Golay coding is not required and the requirement is eliminated, freeing bits in the downlink data stream.

Reqt. A: All requirement for Golay Coding is deleted.

3.5. Virtual Channel Data Unit (VCDU) Format

The VCDU is a fixed length data unit which is a collection of variable length packets. The VCDU is used to package the variable length packets into a data package that can be forwarded for encoding and inclusion in a telemetry frame. In addition, the VCDU provides a method to reduce the onboard latency for priority Engineering and OPNAV data and provides a means to identify data sets that may need special handling on the ground.

Reqt. A: Virtual Channel Data Units (VCDUs) shall be formed from one or more variable length packets as shown in Figure 3.5.1. The VCDU will have a 32 bit header with 3 bits for VCDU ID, 20 bits for sequence number and 9 bits for a pointer to the first byte of the first full packet. There are seven different VCDU types (plus one spare). Allowable VCDU IDs are listed in Table 3.5.1.

Reqt. B: The first packet pointer refers to the location of the first byte of the first packet header in the VCDU referenced from the start of the data area. If the VCDU contains only one packet that is also a remnant from the prior VCDU (i.e. there is no start of first packet in the VCDU) the first packet pointer will be set to 1FFh.

Reqt. C: Each VCDU, with the exception of the BDT VCDUs (VCDU IDs 101, 110 and 111), will have a separate sequence counter.

VCDU ID (3)	SEQ NO (20)	FIRST PKT PTR (9)	REMNANT OF PRIOR PACKET FROM INSTR	FIRST FULL PACKET	FULL PACKET(S)	PARTIAL PACKET
VCDU HDR (4 bytes)			VCDU CONTENTS (442 BYTES)			

Figure 3.5.1 - General VCDU Structure

VCDU ID	VCDU TYPE
000	Priority Data (Engineering and OPNAV)
001	Real Time Science (RTS)
010	Playback Data (Recorded and/or Burst To Tape)
011	Record Rate Change Coverage (RRCC) Data
100	Spare
101	Buffer Dump to Tape: Real Time Science (RTS)
110	Buffer Dump to Tape: Playback Data and/or Burst to Tape
111	Buffer Dump To Tape: Record Rate Change Coverage (RRCC)Data

Table 3.5.1 - VCDU ID Values

3.6. Packet Telemetry Definition

The packet is the basic data unit for packetized telemetry. Each data source will have one or more packet types which uniquely identify the data source and the algorithms used to process that data. The packets are of variable length, however once a packet definition has been set, the data unit is fixed (except for variability due to data compression).

3.6.1. General Requirements

Reqt. A: All telemetry data will contain identifiers such that the GDS can identify and process the data without requiring predicts. EXCEPTION: SSI, NIMS and PWS data recovery will require predicts to process the data.

Comment: This requirement dictates that the basic packet provide indicators of the data source and processing algorithm used for the data so that the data can be fully recovered. This is augmented with the VCDU ID, which will differentiate the various VCDU types and whether the data is Buffer Dump to Tape data, and thus out of time order.

Reqt. B: The capability shall be provided to collect, edit and compress Engineering, Real Time Science and Playback data into variable length packets to facilitate ground processing and identification of the source.

Reqt. C: The variable length packets shall have the generic structure as shown in Figure 3.6.1 and specific formats for each data source shall be as specified in 3.9.

<table>
<tr><td>TIME INCL FLAG

(1)</td><td>APP ID

(7)</td><td>PKT SIZE

(9)</td><td>SEQ NO.

(7)</td><td>FMT ID (OPT)
(0, 4 or 8)</td><td>PKT TIME (OPT)
(20, 24, 28 or 32)</td><td rowspan="2">INSTRUMENT SCIENCE DATA AND STATUS

CONTENT DEFINED BY INSTRUMENT</td></tr>
<tr><td></td><td></td><td></td><td></td><td colspan="2">(24, 32 or 40)</td></tr>
<tr><td colspan="6">PACKET HEADER (3 - 8 BYTES)</td><td>PACKET DATA (20 - 511 BYTES)</td></tr>
</table>

NOTES:
- OPTIONS (FORMAT ID AND PACKET TIME) AND THE SPECIFIC CONTENT OF THE PACKET ARE USER DEFINABLE AT DESIGN TIME, NOT DURING OPERATION. INSTRUMENTS MAY DECIDE TO NOT USE THE FORMAT ID OR PACKET TIME OPTIONS, IF THEY ARE NOT NECESSARY. THE DATA AREA THEN BECOMES LARGER BY UP TO 5 BYTES. AVERAGE PACKET SIZE IS ALSO DETERMINED AT DESIGN TIME.

Figure 3.6.1 - Generalized Packet Structure

3.6.1.1. Packet fields

Reqt. A: The packet will consist of a header field and a data field. The header field will have up to 8 bytes. Header bit definitions are given in Table 3.6.1.1.1. The data field will contain a minimum of 20 bytes of data and a maximum of 511 bytes of data. The data field may be compressed. Header information will not be compressed.

Header Field (bits)	Field Description
1	Time Included Flag (if set, PKT TIME is included)
7	Application ID (max 128 applications)
9	Packet Size (in Bytes, max 511 bytes)
7	Sequence Number
0,4 or 8*	Optional Format ID (max. 256 FMT IDs per APP. ID)
20, 24, 28, or 32*	Packet Time (no. of bits depend on Seq. no., application)

*Number of bits in optional fields must total 0, 8, 24, 32 or 40. Packet time, if included, must have a minimum of 20 bits of RIM.

Table 3.6.1.1.1 - Packet Header Definition

3.6.1.2. Time Correlation of Data

Reqt. A: Time will be included periodically in each series of packets from a given Application ID sufficient to allow unambiguous identification of the time order of the packets.

Comment: The sequence number will be used to reassemble packets in the proper order when time is not included.

3.6.1.3. AACS Pointing Correlation of Data

Reqt. A: All AACS pointing measurements in a single measurement set shall be retrieved from the AACS during a single minor frame report cycle and stored on tape as a coherent entity.

Reqt. B: The AACS sampling rate for Real Time data is once every 5 RIMs. AACS measurements sampled are Rotor RA, Rotor DEC, Rotor Twist, Platform RA, Platform DEC, Platform Twist and Spin rate.

Comment: The sampling frequency for RTS downlink shall be consistent with the ability to subsequently interpolate to the minor frame sampling at an accuracy of 0.5 degrees for the Rotor RA/DEC/TWIST. During EUV and UVS operation, sampling shall be consistent with an ability to interpolate Rotor and scan platform RA/DEC/TWIST to an accuracy of 0.1 degrees.

Reqt. C: During Record Mode the AACS measurements Rotor RA, Rotor DEC, Rotor Twist, Platform RA, Platform DEC, Platform Twist, and time (two bytes, lower RIM and minor frame count) shall be stored on tape every minor frame.

Reqt. D: During PPR burst to Tape mode two AACS measurements only (Platform RA and Platform DEC) are collected each time PPR non-repeat data is collected.

3.6.1.4. Sensor Data and Science Housekeeping Data Correlation

Reqt. A: Science housekeeping data required for instrument safety shall be extracted from the instrument LPW data stream or from the instrument Real Time data stream and placed in the fixed engineering frame. Ancillary housekeeping data required for instrument health assessment and data evaluation will be acquired through MROs. Housekeeping data requirements for each instrument are addressed in Appendix C.

Reqt. B: All science housekeeping for playback mode shall be extracted from the LPW data stream and placed in science playback packet as part of the playback data.

3.6.2. List of Packets Identified (Packet ID)

Reqt. A: The packets identified in Table 3.6.2 are required. The full packet structure for a typical packet ID is described in 3.9 and full packet structures for all packets are identified in GLL 3-310.

APPLICATION ID MNEMONIC	HEX (7 bits)	FORMAT ID	Comments
ENG1	01h	none	R/T Engineering Data
ENG2	02h	none	Engineering Playback Data
AACS1	03h	none	AACS R/T Data
AACS2	04h	none	AACS Playback Data
AACS3	05h	none	AACS Record Rate Change Coverage
OPN1	06h	none	OPNAV R/T Extended Body Limb/Term.
OPN2	07h	none	OPNAV R/T Star Window Data
OPN3	08h	none	OPNAV PB Extended Body Limb/Term.
OPN4	09h	none	OPNAV PB Star Window Data
SSI1	0Ah	none (1)	SSI non-BARC Compressed Imaging
SSI2	0Bh	none (1)	SSI BARC-Compressed Imaging
SSI3	0Ch	none (1)	SSI Housekeeping + AACS
NIMS1	0Dh	none	NIMS R/T Data
NIMS2	0Eh	TBD	NIMS Playback Data
PPR1	0Fh	none	PPR Playback Data
PPR2	10h	none	PPR Burst to Tape data
EUV1	11h	none	EUV R/T Data
EUV2	12h	none	EUV Playback Data
UVS1	13h	none	UVS R/T Data
UVS2	14h	none	UVS Playback Data
UVS3	15h	none	UVS Record Rate Change Data
MAG1	16h	1h: R/T 2 bps 2h: R/T 4 bps 3h: R/T 6 bps 4h: R/T 8 bps 5h: R/T 10 bps 6h: R/T 12 bps	MAG R/T Data
MAG2	17h	none	MAG Playback Data
MAG3	18h	none	MAG Record Rate Change Data
DDS1	19h	1h: R/T 1.1 bps 2h: R/T 3.4 bps	DDS R/T Data
DDS2	1Ah	none	DDS Playback Data
DDS3	1Bh	none	DDS Record Rate Change Data

APPLICATION ID MNEMONIC	HEX (7 bits)	FORMAT ID	Comments
PLS1	1Ch	1h: R/T 5 bps 2h: R/T 10 bps 3h: R/T 15 bps 4h: R/T 20 bps 5h: R/T 30 bps 6h: R/T 40 bps	PLS R/T Data
PLS2	1Dh	none	PLS Playback Data
PLS3	1Eh	none	PLS Record Rate Change Data
PWH1	1Fh	none	PWS High Rate Fill Data
PWH2	20h	TBD	PWS High Rate Playback Data. FMT ID gives "n" for 1 of n lines returned editor, defines the data acquisition rate.
PWH3	21h	TBD	PWS High Rate LPW Golay Rep. Data. FMT ID gives "n" for 1 of n lines returned editor, defines the acq. rate.
PWH4	22h	TBD	PWS High Rate LPW Record Rate Change. FMT ID gives "n" for 1 of n lines returned editor, def. the acq. rate
PWL1	23h	TBD	PWS Low Rate R/T Data, FMT ID gives the Q factor used for the data compression
PWL2	24h	none	PWS Low Rate Playback Data
PWL3	25h	none	PWS Low Rate Record Rate Change Data
EPD1	26h	1h: R/T 5 bps 2h: R/T 10 bps 3h: R/T 15 bps 4h: R/T 20 bps 5h: R/T 30 bps 6h: R/T 40 bps	EPD R/T Data
EPD2	27h	none	EPD Playback Data
EPD3	28h	none	EPD Record Rate Change Data
HIC1	29h	two 2-bit fields: 01xx: Rate data 10xx: PHA data 11xx:status data yy01:acq.1 bps yy10:acq.2 bps yy11:acq. 5 bps	HIC Rate, PHA and Status Data (for FMT ID, RATE, PHA or status information can be acquired at any rate.

APPLICATION ID MNEMONIC	HEX (7 bits)	FORMAT ID	Comments
HIC2	2Ah	none	HIC Playback Data
HIC3	2Bh	none	HIC Record Rate Change Data

(1) Last four (4) bits of the image count reside in the area reserved for the Format ID.

Table 3.6.2.1 - Packet IDs

3.7. Operating Modes

The two main operating modes are RECORD and PLAYBACK. Simultaneous with either of these modes are Real Time modes to support Engineering, OPNAV and Real Time Science.

Reqt. A: Any Real Time mode can be operable with any Record mode or Playback mode. A Record mode can only be activated when Playback mode is not active or is paused. Playback mode cannot be activated while in a Record mode.

Comment: The LPB mode is an unique R/T mode included for diagnostics and ground testing. It is strictly a tape playback mode at 7.68 kbps and precludes any other R/T or Record rate.

3.7.1. Record Modes

There are extensive modifications to the record mode capabilities to support the Phase II implementation. These modifications include deletion of some existing record formats, addition of new formats and the replacement of LRS data with LPW. Additional record formats are added for the Buffer Dump to Tape and PPR Burst-to-Tape operations. All record mode formats are defined in Appendix A.

3.7.1.1. Deletions

Reqt. A: The following DMS record formats will be deleted:

MPR, XED, XCM, XPW, XRW, HCJ, HRW, MPB, XPB, XPN, HPB, HPJ, BPB, PW8, LRS, LPR, HCM, PW4

3.7.1.2. Modifications

Reqt. A: All modes that are retained will replace LRS data with LPW data.

3.7.1.3. Additions

3.7.1.3.1. Regular Tape Recorded Modes

Reqt. A: The following new record modes will be added:

BDT -Buffer Dump to Tape
BPT - PPR Burst to Tape
LNR - Low Rate Science + NIMS
LPU - NIMS Data + UVS and PPR
HIS - High Rate SSI + NIMS
HCA - High Rate NIMS and SSI
HMA - High Rate NIMS and SSI + PWS

Reqt. B: HCA format will be the same as HCM mode (deleted) with the exception that only lines 1 - 200 will be read out.

Reqt. C: HMA format will be the same as HIM mode with the exception that only lines 1 - 400 are read out.

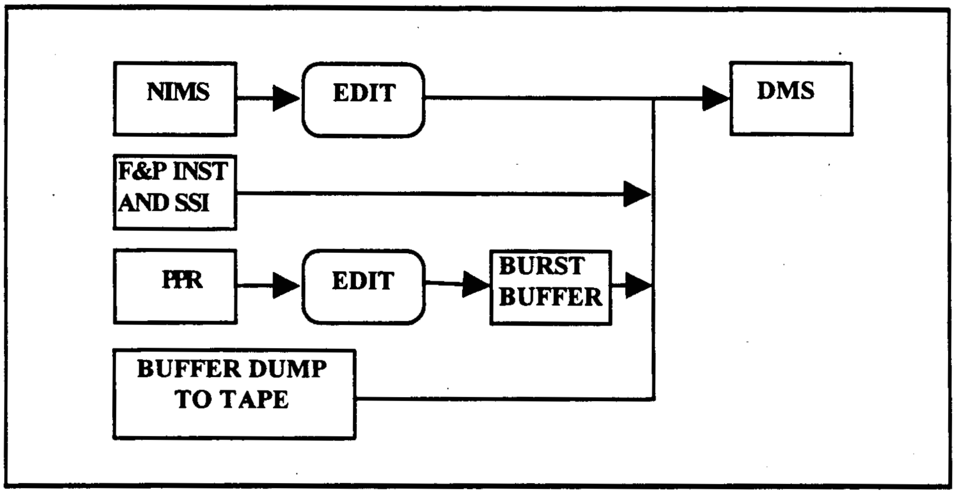

Figure 3.7.1.3.1.1- Record Data Flow

3.7.1.3.2. Record Rate Change Buffering

Reqt. A: The capability shall be provided for capturing the LPW portion of the record format, which contains fields and particles instruments and the UVS instrument, and place this record mode data in the RTS data stream during the time of record gaps due to record rate changes.

Comment: A special record rate change VCDU has been defined for the Record Rate Change data (see 3.5). This VCDU will be processed as if it was an RTS VCDU and will be placed in the multi-use buffer.

Reqt. B: The unused space in the final Record Rate Change VCDU at the completion of a record rate change will be filled with fixed pattern fill data to complete the VCDU.

Reqt. C: Provide Select/Deselect capability for RRCC.

3.7.1.3.3. Burst to Tape Mode

Reqt. A: To reduce use of tape resources, the capability shall be provided to record burst mode data from the PPR instrument as shown in Figure 3.7.1.3.1.1.

Comment: A characteristic of the burst mode of data recording is the collection of data in a buffer over a period of time prior to recording. This is necessary to overcome the slow data collection rate relative to the slowest DMS record rate (7.68 kbps). The buffer used for Burst to Tape mode is also shared with regular record modes which contain NIMS data and with SSI processing.

Reqt. B: AACS data from the LPW data stream will be captured with PPR burst to tape data.

Reqt. C: The data recorded in burst to tape mode will be retrieved via the playback table process.

3.7.1.3.4. Buffer Dump to Tape

Reqt. A: Provide for the sequenced dumping of the multi-use buffer to tape. Upon the issuance of a sequence command (6TMCHG X,XXX,BDT), the CDS will transfer all processed VCDUs in the multi-use buffer to the DMS. Raw data in the buffer (data not yet processed into VCDUs) and completed VCDUs that arrive in the multi-use buffer after the issuance of the BDT command will not be transferred to the DMS.

Comment: If a buffer dump to tape is required during playback, the playback process must be paused (6TMCHG X,XXX,PPB) and the tape properly positioned prior to the issuance of the buffer dump to tape command (6TMCHG X,XXX,BDT).

3.7.2. Real Time Modes

There are real timeformats for Engineering, Real Time Science (RTS) and OPNAV data. Engineering sample rates for real time data are limited to 2 bps, 10 bps and 40 bps in packetized telemetry modes, and 10 bps and 40 bps in TDM modes. For real time science, 9 formats have been defined, with sample rates for each instrument specified by the mode. Additionally, individual instruments or multiple instruments can be deselected from data collection in any RTS mode, and the RTE data collection can be deselected in any telemetry mode.

3.7.2.1. Deletions

Reqt. A: Delete MRO support for 8 and 16 bps TDM rates.

Comment: The 8 and 16 bps TDM modes are being deleted for the Phase II mission (see 3.2.1).

3.7.2.2. Modifications/Additions

Reqt. A: Delete the 80 byte MRO capability and replace with the 32 byte MRO capability.

3.7.2.3. Priority Buffer Modes

Engineering and OPNAV data has priority over Real-Time Science and Playback data. To accommodate this priority, a separate priority buffer (4 Kbytes) will be provided to store up to nine VCDUs of priority data. This data will not be subject to buffer dump to tape and any completed VCDUs in the priority buffer will be forwarded to the next available slot in the downlink telemetry frame.

Reqt. A: The Engineering and OPNAV VCDUs will have priority over RTS and recorded data for inclusion into a telemetry frame. Within the priority buffer, Engineering and OPNAV data have the same priority.

Reqt. B: On buffer overflow, newest data will be discarded.

3.7.2.3.1. Real Time Engineering

Reqt. A: The capability shall be provided to collect and return packetized engineering data according to the table of realtime telemetry modes specified in Table 3.2.2.1. The required collection rates for Real-Time Engineering (RTE) are 2, 10, and 40 bps. The data will be placed into packets in accordance with 3.6 and 3.9, which will then be placed in VCDUs in accordance with 3.5.

Comment: Engineering and OPNAV data will be mixed in the priority VCDU. Segregation of priority data will be at the packet level.

Reqt. B: 10 bps, 40 bps (Spun LLM), and 1200 bps (Despun LLM) Engineering TDM modes are retained. However, the data structure will be the same as that for packetized telemetry (see 3.10 for changes and modifications to the fixed telemetry structure).

Comment: The 1200 bps from the Despun LLM is for ground testing only and cannot be used in flight. This is the source of the IUS port data for testing in the testbed.

Reqt. C: The capability shall be provided to extract the embedded 1200 bps engineering telemetry from the recorded LPW data and make it available for inclusion in the telemetry frame as playback data under playback table control.

Comment: The extracted 1200 bps engineering data will be processed as playback data and will not be placed in the priority buffer for downlink. The data will be placed in the multi-use buffer and will come down in sequential order with other playback and RTS data.

Reqt. D: The priority buffer shall be sized to allow storage of up to fifty (50) minutes of engineering data acquired at 10 bps.

Reqt. E: The capability shall be provided to deselect RTE data from the data collection process in any telemetry mode.

3.7.2.3.2. OPNAV

Reqt. A: The capability shall be provided to collect and edit realtime OPNAV data and make it available to the packetization and framing process as shown in Figure 3.7.2.4.1.1. Real time OPNAV data will be collected and processed using special OPNAV editing and processing algorithms as specified in 3-310 - Flight Software requirements. The OPNAV data packets will be structured as given in 3.6 and 3.9, and will be included in priority VCDUs along with engineering data in the priority buffer.

Reqt. B: The capability shall be provided to playback recorded OPNAV data and make it available to the packetization and framing process as shown in Figure 3.7.3.1. OPNAV data will be recorded in the IM8 record mode. After processing the recorded OPNAV data, it will be placed in packets as given in 3.6 and 3.9 and will be placed in priority VCDUs with engineering data in the priority buffer.

Comment: Any unused area in a priority VCDU will be filled with engineering data.

3.7.2.4. Shared Buffer Modes

The multi-use buffer is shared by many processes. All data except Real Time Engineering (RTE) and OPNAV data are processed in the multi-use buffer. Both raw data and processed VCDUs may occupy the buffer at any given time, and the buffer fill state will be controlled using programmable high and low buffer fill pointers for record data playback.

Reqt. A: The capability shall be provided to buffer data acquired from DMS playback and return as shown in Figure 3.7.3.1. Playback data will be processed as specified in 3-310 - Flight Software Requirements.

Reqt. B: VCDUs in the multi-use buffer will be downlinked in time order.

3.7.2.4.1. Real Time Science (RTS) Formats

Reqt. A: The capability shall be provided to collect and optionally edit Real Time Science (RTS) data in a buffer for later return as depicted in Figure 3.7.2.4.1.1.

Comment: Nine instruments (NIMS, EUV, UVS, MAG, DDS, PLS, PWS low rate, EPD and HIC) and AACS, require data pickup for insertion in the RTS data stream. This data will be processed using instrument specific algorithms prior to downlink. These algorithms are specified in 3-310 - Flight Software Requirements.

Reqt. B: Provide 9 RTS telemetry formats as shown in Table 3.7.2.4.1.1.

Reqt. C: Provide the capability to deselect R/T science data collection from one or more instruments, in any RTS format.

Reqt. D: Instrument data shall be collected in a manner to continuously support the average rates (bps) shown in Table 3.7.2.4.1.1.

Fmt	RTS Data Rate w/HIC	w/EUV	MAG	EPD	PLS	PWS	DDS	HIC	EUV	UVS	NIMS	AACS
A	19.7		2.0	5.0	5.0	5.0	1.1	1.0	0.0	0.2	0.0	0.4
B	20.7		2.0	5.0	5.0	5.0	1.1	2.0	0.0	0.2	0.0	0.4
C	30.8	30.8	2.0	5.0	5.0	5.0	3.4	5.0	5.0	5.0	0.0	0.4
D	32.8	40.8	2.0	5.0	5.0	5.0	3.4	2.0	10.0	10.0	0.0	0.4
E	59.8	67.8	4.0	10.0	10.0	10.0	3.4	2.0	10.0	10.0	10.0	0.4
F	66.8		6.0	15.0	15.0	15.0	3.4	2.0	0.0	10.0	0.0	0.4
G	91.8	91.8	8.0	20.0	20.0	20.0	3.4	5.0	5.0	5.0	10.0	0.4
H	117.8		12.0	30.0	30.0	30.0	3.4	2.0	0.0	10.0	0.0	0.4
I	151.8		16.0	40.0	40.0	40.0	3.4	2.0	0.0	10.0	0.0	0.4

Note: HIC and EUV cannot be included in a format at the same time. One or the other will always be deselected.
RTS data rate is the collection rate from the instruments prior to packetization and R/S overhead. Compression is assumed for PWS.

Table 3.7.2.4.1.1 - Science Telemetry Formats

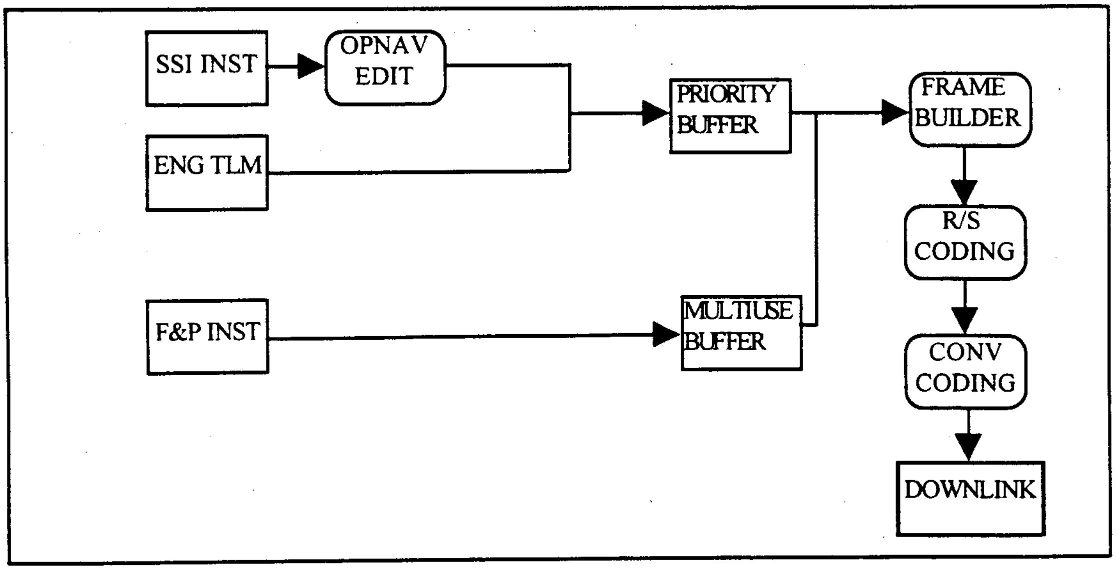

Figure 3.7.2.4.1.1 - Real-Time Data Flow

3.7.2.4.2. Mode Change Synchronization

Reqt. A: The downlink will change data rates in a manner such that no data is lost.

Comment: Changing data rates includes going to and from zero (0) bps downlink rate.

Reqt. B: The capability shall be provided to maintain the current data rate when no data remains to downlink.

Reqt. C: The capability shall be provided to insert one or more telemetry frames of non-critical spacecraft data into the downlink stream for the purpose of DSN receiver signal acquisition.

Comment: When no data is available to downlink, the CDS will construct telemetry frames consisting of high rate PWS data to insert on the downlink. This capability will also be used to construct the dummy frames of spacecraft data for DSN receiver signal acquisition.

Reqt. D: When switching downlink telemetry rates, the spacecraft will be able to switch data rates on 64 byte boundaries.

Comment: the CDS will change the downlink data rate on 128 second boundaries, which is an integral multiple of 64 bytes at all D/L data rates.

Reqt. E: When switching R/T rates, CDS will issue commands to the instruments for the new rate and will begin picking up data at the new rate on the next instrument cycle boundary. See 3-310 for specific instrument exceptions.

Reqt. F: When switching from a real time only mode to a Record mode, the instrument cycle shall be ignored and the switch to record mode will occur regardless of where the instrument is in its cycle.

Reqt. G: When switching from one record mode to another record mode, the instrument cycle will be ignored and the change will occur when commanded regardless of where the instrument is in its cycle.

Reqt. H: When switching from a record mode to a Real Time mode, CDS will begin picking up data from the instrument at the new rate on the next instrument cycle boundary. See 3-310, 3-270 for specific instrument exceptions. Some instruments can generate both RTS and Record data simultaneously.

Comment: When switching between R/T and Record data, Record data has higher priority. The instruments desire to maximize the collection of Record data at switches between R/T and Record modes.

3.7.3. Tape Data Playback

All data playback from the DMS will be controlled via playback tables as defined in 3-290 - Command Structure and Assignments, and 3-310 Flight Software Requirements. Data will be read from the DMS at 7.68 Kbps and placed in the multi-use buffer as illustrated in Figure 3.7.3.1. SSI data will be processed and assembled into VCDUs prior to entry into the multi-use buffer. All other data will be placed into the multi-use buffer as raw data and processed to packets and placed into VCDUs upon pausing of the playback (buffer full). Any data that will not be downlinked will be deselected and will not be placed into the multi-use buffer.

Reqt. A: When the playback process is active, the buffer fill state will be controlled via programmable high and low water marks.

Comment: When the buffer fill state reaches the lower mark, the playback process will autonomously initiate DMS data playback to fill the buffer. This includes backing up the tape recorder to recover data passed up in the previous tape run-down, allowing data playback to proceed from where it halted in the previous buffer fill. When the buffer fill state reaches the upper mark, the playback process will autonomously cease DMS playback and process the raw data in the buffer into VCDUs.

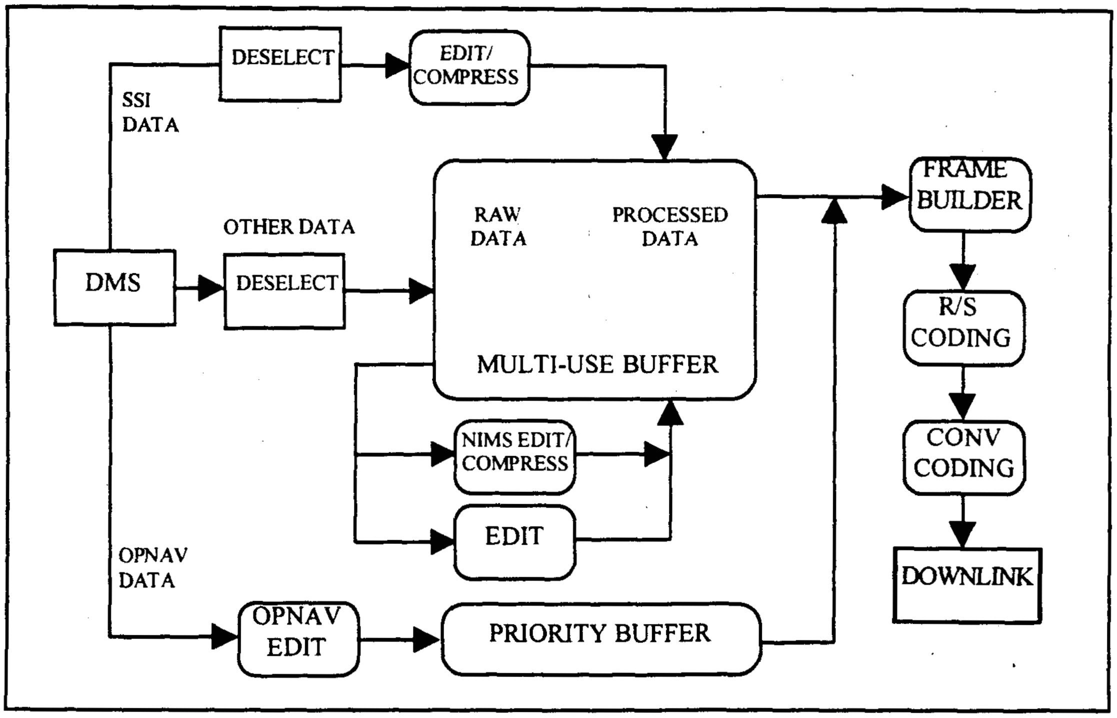

Figure 3.7.3.1 - Playback Data Flow

3.7.3.1. Playback Table Controls

Reqt. A: The DMS data shall be played back and processed according to the playback table, the contents of which is specified on the ground and uplinked to the spacecraft. This data will be placed into packets according to 3.6 and 3.9.

3.8. Data Compression

Data Compression is used to minimize the number of bits that must be transmitted from the spacecraft to the ground. Compression consists of two basic types: lossless compression and lossy compression. Lossless compression is characterized by the ability to fully recover the compressed data with no loss of fidelity. Lossy compression is characterized by the fact that in the compression process, data is intentionally lost in order to maximize compression. For the SSI playback data, a lossless compressor based upon the Huffman algorithm will be available. For NIMS playback, an editor and a lossless compressor based on the RICE algorithm is used. For lossy compression the Integer Cosine Transform (ICT) compression algorithm is used for SSI playback and PWS R/T low rate data. Expected algorithms and compression ratios are given in Table 3.8.1.

Data Type (Instrument)	Mode	Algorithm	Comp. Ratio
NIMS	PB	Rice	1 - 5
PWS Low Rate	R/T	ICT	2 - 80
SSI	PB	ICT+Huffman	1 - 80

Table 3.8.1 - Compression Algorithms

3.9. Detailed Packet Data Description

This section describes the packet structure for each Application ID to the extent required to identify specific data as needed for ground processing in AMMOS Telemetry, Data Records, or Science Processing at JPL.

Packet definitions are contained in 3-310 - Flight Software Requirements. The following is a packet description of a typical packet (as an example).

Time inc.	App ID	Size	Seq. #	(Time)	Data1	Data2	...	Data200
1	7	9	7	32	8	8	...	8
	NIMS1			R-R-R-MF/2				

Table 3.9.1 - NIMS R/T Data Packet

The NIMS R/T packet is illustrated in Table 3.9.1. The data fields in this packet are:

Time inc. (1 bit): 1 - Time is included in the time field
0 - Time not included (no time field)

App. ID (7 bits): (will include Application ID bit pattern here)

Size (9 bits): (Size will be fixed at completion of packet definition, max 511 bytes)

Seq # (7 bits): Rolls over at 128.

(Time) (32 bits): Included if Time inc. bit set to 1. If included, format is :
R-R-R-MF/2 - Full Rim count plus minor frame with high order bit set if data taken in RTIs 5-9. At least 20 bits of RIM must be included.

Data1(8 bits): First data field.

Data2(8 bits): Second data field.

Data200(8 bits): Last data field.

3.10 Fixed Telemetry

3.10.1 Modifications

Reqt. A: The CDS shall provide visibility into the playback table processing status and telemeter this status to the ground.

Reqt. B: Provide capability for the timely identification of anomalous uplink.

Comment: This requirement can be satisfied by providing telemetry indicators of anomalous uplink at the highest engineering sample rate. Counters for commands accepted and commands rejected will be included in 7 or 13 deck telemetry positions and a variable packet map will be defined which contains the 32 byte missing message list. Other HLM telemetry measurements that will assist in the assessment of an anomalous uplink will also be included in the variable map.

Reqt. C: Provide status telemetry on the state of the multi-use buffer and the priority buffer including a buffer overflow indicator.

Reqt. D: Provide the capability to insert a selected set of CDS HLM telemetry measurements into the 7 and 13 level commutation decks and into variable packets

Comment: The CDS HLM commutator structure has only 91 deck positions. A selected set of CDS data needs to be inserted in faster decks for more frequent updates.

Reqt. E: When switching data rates, telemetry sampling will restart only when the data rate change affects the Real Time Engineering (RTE) data acquisition rate.

APPENDIX A - RECORD FORMATS

The structures for all of the record formats used in Phase II are contained in this appendix. This includes all existing formats that are retained (MPP, MPW, HIM, HPW, IM4, AI8 and IM8), new formats for Phase II (LNR, LPU, HIS, HCA and HMA), all formats added in Phase I and retained in Phase II (LPW). Note that the new HMA format is the same as the HIM format except that only lines 1 - 400 are read out. The new HCA format is the same as the old HCM format (deleted) except that only lines 1 - 200 are read out.

BDT - Buffer Dump to Tape

Data Rate: 7.68 Kbps

Engineering: 0 bps

Frame Length: 15360 bits

Frame Time: 2.0 seconds

HDR	VCDU	VCDU	VCDU	VCDU	Filler
96	3568	3568	3568	3568	992

Data Description	Bits/Frame	Bits/sec	Offset to Start of data
Header	96	48	0
VCDU	3568	1784	96
VCDU	3568	1784	3664
VCDU	3568	1784	7232
VCDU	3568	1784	10800
Filler	992	496	14368
TOTAL	15360	7680	

BPT - PPR Burst to Tape

Data Rate: 7.68 Kbps

Engineering: 0 bps

Frame Length: 2560 bits

Frame Time: 0.333 1/3 seconds

HDR	PPR1	AACS1	PPR2	AACS2	......	PPR14	AACS14
96	144	32	144	32	(2224 BITS)	144	32

Data Description	Bits/Frame	Bits/sec	Offset to Start of data
Header	96	288	0
14 PPR/AACS Blocks	2464	7392	96
TOTAL	2560	7680	

LNR - Low Rate Science + NIMS

Data Rate:	7.68 Kbps
Engineering:	1200 bps (effective)
Frame Length:	5120 bits
Frame Time:	0.666 2/3 seconds

HDR	Eng.	UVS	HIC/ EUV	SSI Sta.	PLS	NIMS Sta.	NIMS	DDS	Coded Reserve	EPD	NIMS
96	704	672	96	96	408	24	432	16	16	400	432

EPD	PPR	MAG	NIMS	MAG	PWS (LR)	AACS	NIMS
208	144	80	432	80	160	192	432

Data Description	Bits/Frame	Bits/sec	Offset to Start of data
Header	96	144	0
Engineering data	704	1056	96
UVS	672	1008	800
HIC/EUV	96	144	1472
SSI Status	96	144	1568
PLS	408	612	1664
NIMS Status	24	36	2072
NIMS (part 1)	432	2592	2096
DDS	16	24	2528
Coded Reserve	16	24	2544
EPD (part 1)	400	912	2560
NIMS (part 2)	432	--	2960
EPD (part 2)	208	--	3392
PPR	144	216	3600
MAG (part 1)	80	240	3744
NIMS (part 3)	432	--	3824
MAG (part 2)	80	--	4256
PWS Low Rate	160	240	4336
AACS Pos. & Rate data	192	288	4496
NIMS (part 4)	432	--	4688
TOTAL	5120	7680	

LPU - NIMS data + UVS and PPR

Data Rate: 7.68 Kbps

Engineering: 1200 bps (effective)

Frame Length: 5120 bits

Frame Time: 0.666 2/3 seconds

HDR	NIMS	UVS	PPR	AACS
96	4112	672	144	96

Data Description	Bits/Frame	Bits/sec	Offset to Start of data
Header	96	144	0
NIMS	4112	6168	96
UVS	672	1008	4208
PPR	144	216	4880
AACS	96	144	5024
TOTAL	5120	7680	

HIS - High Rate SSI + NIMS

Data Rate: 115.2 Kbps

Engineering: 1200 bps (in LPW stream)

Frame Length: 7680 bits

Frame Time: 0.066 2/3 seconds

HDR	LPW 1/10	NIMS	SSI 1	SSI 2
96	512	768	3152	3152

Data Description	Bits/Frame	Bits/sec	Offset to Start of data
Header	96	1440	0
1/10 LPW	512	7680	96
NIMS	768	11520	608
SSI 1	3152	47280	1376
SSI 2	3152	47280	4528
TOTAL	7680	115200	

HCA - High Rate NIMS and SSI

Data Rate: 115.2 Kbps

Engineering: 1200 bps (in LPW stream)

Frame Length: 7680 bits

Frame Time: 0.066 2/3 seconds

HDR	LPW 1/10	NIMS	Compressed Imaging	R/S Code	Compressed Imaging	R/S Code	Filler
96	512	768	2592	512	2592	512	96

Data Description	Bits/Frame	Bits/sec	Offset to Start of data
Header	96	1440	0
1/10 LPW	512	7680	96
NIMS	768	11520	608
Compressed Imaging	2592	38880	1376
R/S Code	512	7680	3968
Compressed Imaging	2592	38880	4480
R/S Code	512	7680	7072
Filler	96	1440	7584
TOTAL	7680	115200	

HMA - High Rate NIMS and SSI + PWS

Data Rate: 115.2 Kbps

Engineering: 1200 bps (in LPW stream)

Frame Length: 7680 bits

Frame Time: 0.066 2/3 seconds

HDR	LPW 1/10	NIMS	Imaging
96	512	768	6304

Data Description	Bits/Frame	Bits/sec	Offset to Start of data
Header	96	1440	0
1/10 LPW	512	7680	96
NIMS	768	11520	608
Imaging	6304	94560	1376
TOTAL	7680	115200	

LPW - Low Rate Science + PWS

Data Rate: 7.68 Kbps

Engineering: 1200 bps (effective)

Frame Length: 5120 bits

Frame Time: 0.666 2/3 seconds

HDR	Eng.	UVS	HIC/ EUV	SSI Sta.	PLS	NIMS Sta.	PWS	DDS	Coded Reserve	EPD	PWS
96	704	672	96	96	408	24	432	16	16	400	432

EPD	PPR	MAG	PWS	MAG	PWS (LR)	AACS	PWS
208	144	80	432	80	160	192	432

Data Description	Bits/Frame	Bits/sec	Offset to Start of data
Header	96	144	0
Engineering data	704	1056	96
UVS	672	1008	800
HIC/EUV	96	144	1472
SSI Status	96	144	1568
PLS	408	612	1664
NIMS Status	24	36	2072
PWS High Rate (part 1)	432	2592	2096
DDS	16	24	2528
Coded Reserve	16	24	2544
EPD (part 1)	400	912	2560
PWS High Rate (part 2)	432	--	2960
EPD (part 2)	208	--	3392
PPR	144	216	3600
MAG (part 1)	80	240	3744
PWS High Rate (part 3)	432	--	3824
MAG (part 2)	80	--	4256
PWS Low Rate	160	240	4336
AACS Pos. & Rate data	192	288	4496
PWS High Rate (part 4)	432	--	4688
TOTAL	5120	7680	

MPP - Medium Rate Science, PWS data without NIMS

Data Rate: 28.8 Kbps

Engineering: 1200 bps (in LPW stream)

Frame Length: 1920 bits

Frame Time: 0.066 2/3 seconds

HDR	LPW 1/10	PWS	Filler
96	512	1280	32

Data Description	Bits/Frame	Bits/sec	Offset to Start of data
Header	96	1440	0
1/10 LPW	512	7680	96
PWS	1280	19200	608
Filler	32	480	1888
TOTAL	1920	28800	

MPW - Medium Rate Science, PWS

Data Rate: 28.8 Kbps

Engineering: 1200 bps (in LPW stream)

Frame Length: 1920 bits

Frame Time: 0.066 2/3 seconds

HDR	LPW 1/10	NIMS	PWS	Filler
96	512	768	512	32

Data Description	Bits/Frame	Bits/sec	Offset to Start of data
Header	96	1440	0
1/10 LPW	512	7680	96
NIMS	768	11520	608
PWS	512	7680	1376
Filler	32	480	1888
TOTAL	1920	28800	

HIM - High Rate Science, Imaging

Data Rate: 115.2 Kbps

Engineering: 1200 bps (in LPW stream)

Frame Length: 7680 bits

Frame Time: 0.066 2/3 seconds

HDR	LPW 1/10	NIMS	Imaging
96	512	768	6304

Data Description	Bits/Frame	Bits/sec	Offset to Start of data
Header	96	1440	0
1/10 LPW	512	7680	96
NIMS	768	11520	608
Imaging	6304	94560	1376
TOTAL	7680	115200	

HPW - High Rate Science, PWS

Data Rate: 115.2 Kbps

Engineering: 1200 bps (in LPW stream)

Frame Length: 7680 bits

Frame Time: 0.066 2/3 seconds

HDR	LPW 1/10	NIMS	PWS
96	512	768	6304

Data Description	Bits/Frame	Bits/sec	Offset to Start of data
Header	96	1440	0
1/10 LPW	512	7680	96
NIMS	768	11520	608
PWS	6304	94560	1376
TOTAL	7680	115200	

IM4 - Compressed Imaging at 403.2

Data Rate: 403.2 Kbps

Engineering: 1200 bps (in LPW stream)

Frame Length: 3360 bits

Frame Time: 0.008 2/3 seconds

HDR	LPW 1/80	NIMS 1/8	Compressed Imaging	Reed-Solomon Parity Symbols
96	64	96	2592	512

Data Description	Bits/Frame	Bits/sec	Offset to Start of data
Header	96	11520	0
1/80 LPW	64	7680	96
1/8 NIMS	96	11520	160
Compressed Imaging	2592	311040	256
Reed Solomon Parity Symbols	512	61440	2848
TOTAL	3360	403200	

AI8 - Imaging Recorded at 806.4

Data Rate: 806.4 Kbps

Engineering: 1200 bps (in LPW stream)

Frame Length: 6720 bits

Frame Time: 0.008 1/3 seconds

HDR	LPW 1/80	NIMS 1/8	Filler	Imaging	Imaging
96	64	96	64	3200	3200

Data Description	Bits/Frame	Bits/sec	Offset to Start of data
Header	96	11520	0
1/80 LPW	64	7680	96
1/8 NIMS	96	11520	160
Filler	64	7680	256
Imaging	3200	384000	320
Imaging	3200	384000	3520
TOTAL	6720	806400	

IM8 - Imaging Recorded at 806.4

Engineering: 1200 bps (in LPW stream)

Frame Length: 6720 bits

Frame Time: 0.008 1/3 seconds

HDR	LPW 1/80	NIMS 1/8	Filler	Imaging
96	64	96	64	6400

Data Description	Bits/Frame	Bits/sec	Offset to Start of data
Header	96	11520	0
1/80 LPW	64	7680	96
1/8 NIMS	96	11520	160
Filler	64	7680	256
Imaging Data	6400	768000	320
TOTAL	6720	806400	

APPENDIX B - REED SOLOMON AND CONVOLUTIONAL CODING

The data to be downlinked is fed to the Reed Solomon process and the software convolutional coder. The data is fed into the Reed Solomon encoder as shown in Figure B-1 in the order specified.

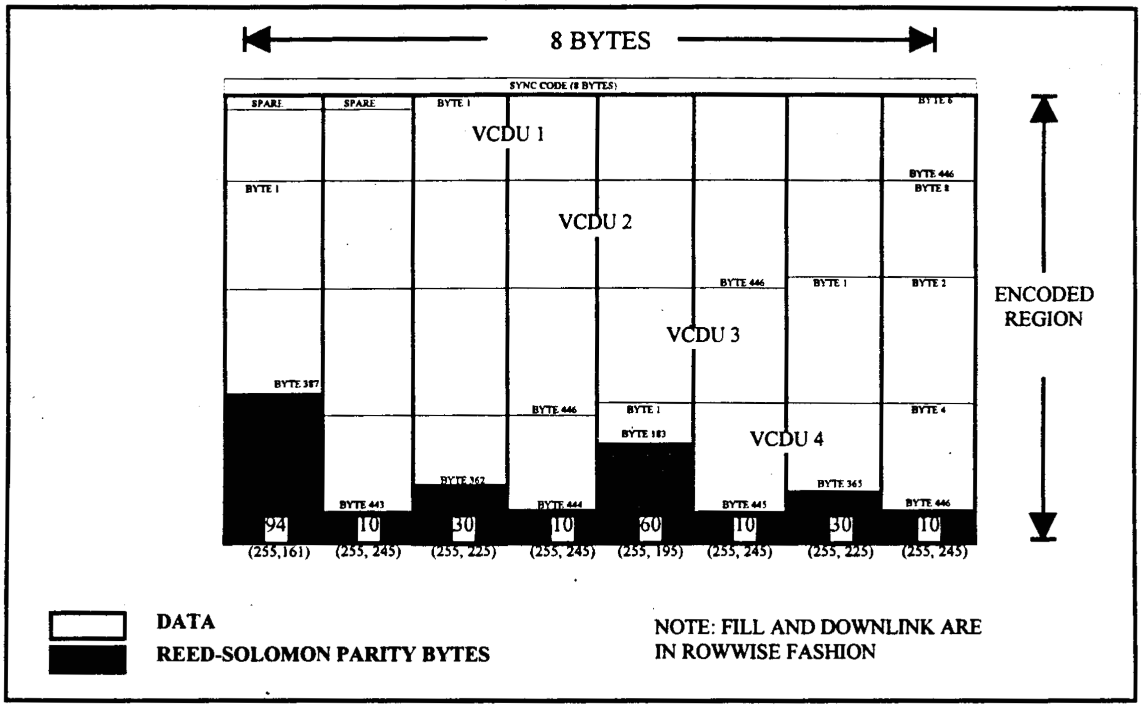

Figure B-1 - Reed Solomon Encoding Frame

When the data is passed to the software Convolutional encoder, the data is read out in accordance with the downlink order of data in figure B-1 with no special processing of parity bytes. Thus the parity bytes are interleaved into the data bytes for VCDUs 3 and 4. Figure B-2 illustrates the interleaving.

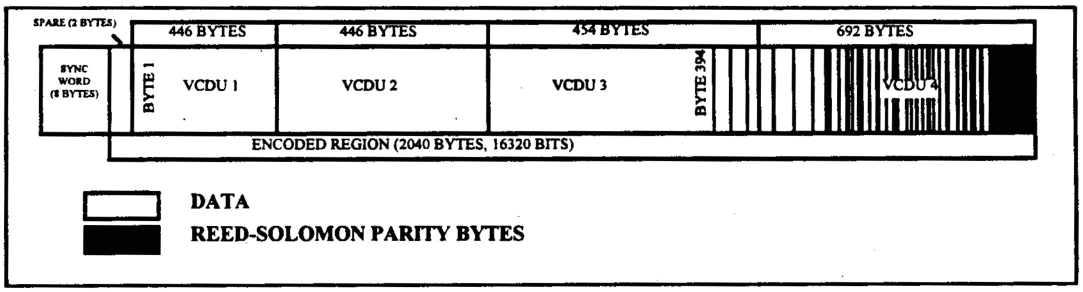

Figure B-2 - R/S Parity Bit Interleave in Convolutional Code Block

APPENDIX C - SCIENCE INSTRUMENT HOUSEKEEPING DATA

Science instrument housekeeping data consists of two main types of data; data required for the monitoring of the health and safety of the instrument, and data required for the assimilation, calibration or interpretation of the instrument data. The health and safety data will be obtained by placing the appropriate channels in the fixed telemetry and retrieving the data with the fixed engineering data. The other housekeeping data will be obtained by multiple methods, specific to the instrument and its operating modes.

The following paragraphs list the housekeeping data requirements for each instrument and the expected method of obtaining that data.

DDS Instrument:

DDS instrument housekeeping data is included in the DDS R/T packet. There is no requirement to extract this data for instrument monitoring.

EPD Instrument:

One byte of science housekeeping data is to be collected directly from the instrument memory and placed into the fixed engineering 91 deck telemetryfor instrument monitoring. Memory location TBD.

EUV Instrument:

EUV instrument housekeeping data will be included in the EUV data packets and will not require extraction for instrument monitoring. Existing engineering data obtained through engineering channel E-1680 will be retained in fixed telemetry.

HIC Instrument:

Housekeeping data for the HIC instrument will be included in the HIC instrument packets. Two engineering channels currently in the fixed engineering will remain for instrument health and safety monitoring.

MAG Instrument:

The MAG instrument will obtain required housekeeping data via Memory Readouts (MROs). Existing engineering measurements in the fixed engineering will remain for monitoring instrument health and safety. Additional X, Y and Z sensor offset data measurements (total of 6 bytes) will be picked up via DMA transfer (BTs) and inserted in the 91 deck of the fixed engineering telemetry structure.

NIMS Instrument:

Science channels S-1924, S-1925, S-1926, S-1927, S-1929 and S-1930 will be obtained directly from NIMS memory (addresses 1592h through 1597h) each minor frame (total of 5 bytes/mf) and placed into the fixed engineering 91 deck telemetry for instrument monitoring.

PLS Instrument:

The PLS has no specialized housekeeping data requirements. Engineering channels E-1751 and E-1764 will be used to monitor the health and safety of the instrument and will be obtained through the fixed engineering 91 deck telemetry.

PPR Instrument:

All PPR housekeeping data will be included in the PPR instrument packets and does not require extraction for R/T instrument monitoring. Engineering channels E-1715 and E-1716 will be included in the fixed engineering 91 deck telemetry for monitoring the health and safety of the instruments.

PWS Instrument:

All housekeeping data for the PWS instrument will be obtained from the recorded LPW data.

SSI Instrument:

For monitoring instrument health and safety, engineering channels E-1880 to E-1885 will be included in the 91 deck of the fixed engineering telemetry structure.

When the instrument is on, the SSI will return 12 bytes of data which are:

S-CHANNELS	DATA TYPE	DESCRIPTION
	DATA WORD TBD	RAM Checksum
	DATA WORD TBD	ROM Checksum
S-1915	DATA WORD 2	Programmed Memory Readout
S-1899, S-1880,S-1901, S-1902, S-1903, S-1904, S-1905, S-1906	DATA WORD 5	State Vector Status
S-1881	DATA WORD 6	Input Current
S-1886	DATA WORD 11	Plus 5 Volts
S-1888	DATA WORD 13	CCD Heater Voltage
S-1890	DATA WORD 15	BLS Voltage
S-1894	DATA WORD 19	CCD Fine Temperature
S-1912	DATA WORD 22	Picture Mode
S-1913, S-1914, S-1916	DATA WORD 25	Image Mode, Compressor Status
S-1900, S-1907, S-1908, S-1909, S-1910	DATA WORD 26	Actual Filter, Watchdog Trip

This data will be included in the 91 deck of the fixed engineering telemetry structure. The additional 15 data words that are not regularly sampled will be periodically retrieved via MRO.

When the instrument is returning images, the SSI will return 7 bytes of data which are:

S-CHANNELS	DATA TYPE	DESCRIPTION
S-1889	DATA WORD 14	RAM Checksum
S-1894	DATA WORD 19	ROM Checksum
S-1912	DATA WORD 22	Programmed Memory Readout
S-1897, S-1875	DATA WORD 23	State Vector Status
S-1898, S-1876, S-1877, S-1878, S-1879	DATA WORD 24	Input Current
S-1913, S-1914, S-1916	DATA WORD 25	Plus 5 Volts
S-1900, S-1907, S-1908, S-1909, S-1910	DATA WORD 26	Actual Filter, Watchdog Trip

This data is returned for each image (including OPNAV) in the special housekeeping packet.

EXCEPTION: In the 2 1/3 second mode only, DATA WORDs 22 - 26 will be returned.

UVS Instrument:

UVS instrument housekeeping data will be included in the UVS data packets and will not require extraction for instrument monitoring. In addition, engineering channel E-1790 will be included in the fixed engineering 91 deck telemetry for instrument health and safety monitoring.

(Insert in [redacted], Galileo Orbiter Functional Requirements Book)

Custodian: R. Johansen

APPROVED:

Spacecraft System Engineer: N. Yarnell

Spacecraft System Software Engineer: R. C. Barry

Engineering Manager: R. J. Reichert

GLL Downlink System Engineer: R. Johansen

JET PROPULSION LABORATORY

No. [redacted], Revision D
1 March 1989

SUPERSEDES:

GLL-3-280, Revision C
13 January 1986

FUNCTIONAL REQUIREMENT

GALILEO ORBITER

TELEMETRY MEASUREMENTS AND DATA FORMATS

Revised and Rewritten

FUNCTIONAL REQUIREMENT AMENDMENT

TITLE:

FUNCTIONAL REQUIREMENT
GALILEO ORBITER
TELEMETRY MEASUREMENTS and DATA FORMATS

FR No. GLL-3-280, Rev. D

AMENDMENT No. 1

PAGE 1 OF 1

DATE: August 1, 1989

PER ECR No. 35034A
35242
35244B
35279
35298
35299
35309
35312
35334
35341

DESCRIPTION OF CHANGE:

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red pages in the attached package.

5/6	161/162
9/10	165/166
53/54	183/184
55/56	187/188
99/100	189/190
103/104	191/192
105/106	193/194
109/110	199/200
113/114	243/244
121/122	249/250
125/126	265/266
129/130	267/268
139/140	269/270
151/152	271/272
153/154	273/274
157/158	389

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R. Johansen
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FUNCTIONAL REQUIREMENT AMENDMENT

TITLE:

FUNCTIONAL REQUIREMENT
GALILEO ORBITER
TELEMETRY MEASUREMENTS and DATA FORMATS

FR No. GLL-3-280, Rev. D

AMENDMENT No. 1

PAGE 1 **OF** 1

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105/106	193/194
109/110	199/200
113/114	243/244
121/122	249/250
125/126	265/266
129/130	267/268
139/140	269/270
151/152	271/272
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R. Johansen
SUBSYSTEM

SUBSYSTEM

SYSTEM

(Insert in 625-205, Galileo Orbiter Functional Requirements Book)

Custodian: R. Johansen

APPROVED:

Spacecraft System Engineer:	N. Yarnell
Spacecraft System Software Engineer:	R. C. Barry
Engineering Manager:	R. J. Reichert
GLL Downlink System Engineer:	R. Johansen

JET PROPULSION LABORATORY

No. GLL-3-280, Revision D
1 March 1989

SUPERSEDES:

GLL-3-280, Revision C
13 January 1986

FUNCTIONAL REQUIREMENT

GALILEO ORBITER

TELEMETRY MEASUREMENTS AND DATA FORMATS

Revised and Rewritten

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FIGURES (cont'd)

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TABLE (cont'd)

1.0 SCOPE

This document establishes the Galileo (GLL) telemetry measurements and data formats. Included are functional requirements and descriptions of the telemetry format structure characteristics for Engineering, Science and Playback data. For the purpose of this document, Telemetry Handling is defined as those functions required to prepare and process either science or engineering data during any phase of the mission for subsequent transmission to earth.

2.0 APPLICABLE DOCUMENTS

The following documents form a part of this functional requirement.

NOTE

GLL-3-100, Galileo Orbiter Requirements and Constraints, applies to this document. Requirements of other GLL level 3 documents may also be applicable. It is the responsibility of the user to adequately acquaint himself with the organization and pertinent contents of the level 3 documents, as well as with the material contained herein.

REQUIREMENTS

Jet Propulsion Laboratory

GLL-3-100 Functional Requirement, Galileo Orbiter Requirements and Constraints

GLL-3-110 Functional Requirement, Galileo Orbiter Functional Block Diagram and Interface Listings

GLL-3-290 Functional Requirement, Galileo Orbiter Command Structure and Assignments

GLL-3-300 Functional Requirement, Galileo Orbiter Telecommunications

GLL-3-310 Functional Requirement Galileo Orbiter Software Requirements

DOCUMENTS

Jet Propulsion Laboratory

PD 625-53 End-to-End Information System

PD 625-59 GLL/STS System Requirements Document

National Aeronautics and Space Administration

NASA Planetary Program Flight/Ground Data System Standards

Johnson Space Center

ICD-2-1F001-002 Shuttle Orbiter/IUS Cargo Element Interfaces (GLL Annex)

Lewis Research Center

ICD-65-69001 Interface Control Drawing STS/IUS/GLL Spacecraft

Ames Research Center

JP-530 Probe System/Orbiter System Interface Specification

3.0 TELEMETRY SYSTEM FUNCTIONAL REQUIREMENTS

3.1 General

The GLL Orbiter shall contain hardware and software to perform the telemetry functional requirements as defined in this document.

The data flow block diagram, depicted in Figure 1, shows the functional flow of all Galileo Orbiter telemetry data.

3.1.1 Engineering Subsystems

The Orbiter engineering subsystems consist of the following:

	Subsystem
a. Structure subsystem (STRU)	01
b. Radio frequency subsystem (RFS)	02
c. Modulation demodulation subsystem (MDS)	03
d. Power/pyro subsystem (PPS)	04
e. Command and data subsystem (CDS)	06
f. Attitude and articulation control subsystem (AACS)	07
g. Cabling subsystem (CABL)	09

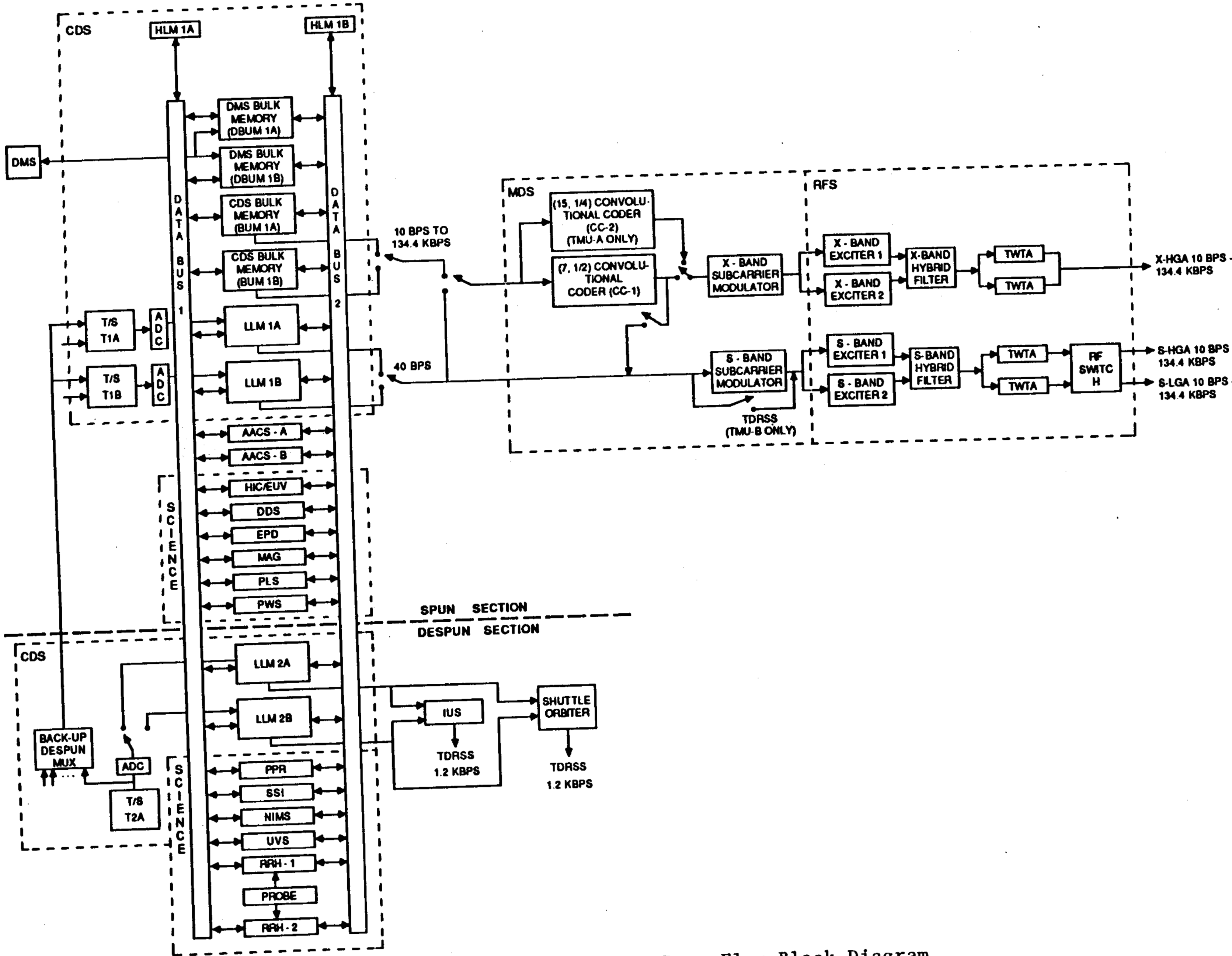


Figure 1. Functional Telemetry Data Flow Block Diagram

h.	Retro Propulsion Module (RPM)	10
i.	Temperature control subsystem (TEMP)	11
j.	Mechanical devices subsystem (DEV)	12
k.	Data memory subsystem (DMS)	16
l.	S/X-band antenna subsystem (SXA)	17
m.	Heavy ion counter (HIC)	28
n.	X/S downconverter subsystem (XSDC)	42
o.	Orbiter purge equipment (OPE)	71

Shuttle engineering subsystems consist of the following:

		Subsystem
a.	IUS	--
b.	Shuttle orbiter (SO)	--

3.1.2 Science Subsystems

The GLL science subsystems consist of the following:

		Subsystem
a.	Plasma wave subsystem (PWS)	23
b.	Extreme ultraviolet subsystem (EUV)	24
c.	Energetic particles detector subsystem (EPD)	25
d.	Photopolarimeter radiometer subsystem (PPR)	27
e.	Dust detector subsystem (DDS)	29
f.	Plasma subsystem (PLS)	32
g.	Ultraviolet spectrometer subsystem (UVS)	34
h.	Magnetometer subsystem (MAG)	35
i.	Solid state imaging subsystem (SSI)	36

3.1.3 Document Conventions

Within this document, the following conventions are followed:

a. All numbers shall be decimal (base 10) unless otherwise indicated.

b. The leftmost bit in any group of bits shall be the most significant bit (MSB) and shall be assigned bit number 1. The rightmost bit in any group of bits is the least significant bit (LSB) and shall be assigned bit "N". Unless otherwise indicated, all data shall be transferred MSB first.

3.2 Data Management

The GLL Orbiter shall process the following types of data:

a. Engineering

b. Memory Read Out

c. Low-Rate Science (LRS)

d. Medium-Rate Science (MRS)

e. Intermediate-Rate Science (XRS)

f. High-Rate Science (HRS)

g. S-band Backup Science (BUS)

h. Playback (PB)

3.2.1 Engineering Data

Engineering data are those measurements required to monitor the executing sequence, the status and performance of engineering subsystems, and the science instrument critical temperatures without prior knowledge of previous state. Redundant measurements for selected critical parameters shall be permitted.

The priority in selecting engineering telemetry measurements for inclusion in the engineering frame is listed below. This order of priorities shall be used in the assignment of measurements to the downlink telemetry frames.

a. Measurements necessary for flight operations or safety, such as S/C pointing, fault identification, and state vector for sequence verification.

   1) Measurements that give positive indication of onboard status and actions (both hardware and software).

   2) Measurements required for selecting between alternate modes of operation or redundant elements.

b. Measurements of subsystem parameters directly affecting spacecraft system performance.

c. Measurements necessary to evaluate the performance of subsystems not previously flown.

d. Measurements necessary to evaluate the performance of a subsystem previously flown.

3.2.2 <u>Memory Readout Data</u>

Memory readout data is the data derived from the memories of the command and data subsystem (CDS), attitude and articulation control subsystem (AACS), or from the science subsystems. The CDS memory can contain 7.68 kbps DMS playback data.

3.2.3 <u>Low-Rate Science (LRS) Data</u>

Low-Rate Science Data consists of engineering, all fields and particles, UVS, EUV, and PPR science instrument sensor data, instrument status/housekeeping data and scan platform pointing vectors. Critical instrument temperatures, used to monitor the instrument health, are located in the engineering data frame.

3.2.4 <u>High-Rate Science (HRS) Data</u>

High-Rate Science Data shall consist of LRS, all data produced by the solid state imaging (SSI), and the near infrared mapping spectrometer (NIMS) subsystems with the exception of those measurements included in the LRS stream for the purpose of monitoring the status of the SSI and NIMS. The HRS data shall include the plasma wave subsystem (PWS) wave-form data which replaces SSI data, is in addition to the SSI data, or is in addition to the Playback data.

3.2.5 <u>Intermediate-Rate Science (XRS) Data</u>

Intermediate-Rate Science data shall be identical to the HRS data except that SSI or PWS data shall be incorporated at a reduced rate. This rate reduction shall be achieved by compression or editing.

3.2.6 Medium-Rate Science (MRS) Data

Medium-Rate Science data shall consist of LRS, with or without NIMS, and either probe or plasma wave subsystem sensor data.

3.2.7 S-band Back-up Science (BUS) Data

The S-band Back-up Science data shall include playback options and other to be selected science modes for use in the event of a loss of X-band downlink.

3.2.8 Playback (PB) Data

Playback data shall consist of LRS data with or without NIMS data with or without PWS data and tape recorder PB data which is asynchronously embedded in a real-time data stream.

3.3 Data Acquisition

All data generated by engineering or science subsystems shall be initially routed to the CDS for conditioning and processing before being sent to the Shuttle Orbiter and the IUS, the modulation/demodulation subsystem (MDS) telemetry modulation unit (TMU), and/or the data memory subsystem (DMS).

3.3.1 Analog Engineering Measurement Resolution

Each temperature and (0-3 volt) analog engineering measurement converted to a digital number within the CDS shall result in an 8-bit word with a data number (DN) ranging from 0 to 255. Therefore, each measurement digitized by the CDS shall have a maximum resolution of 1/256 (0.39%).

3.3.2 Analog Engineering Measurement Accuracy

The accuracy with which the CDS shall convert each temperature and (0-3 volt) analog engineering measurement into an 8-bit digital number shall be as specified below:

a. Standard Range Temperature Measurement (-78 deg. C to +100 deg. C):
   $\pm$ 3% (of full scale) $\pm$ 1/2 DN

b. Electrostatic Discharge Protected Temperature Measurement (-102 deg. C to +74 deg. C):
   $\pm$ 4% (of full scale) $\pm$ 1/2 DN

c. Other Temperature Measurements (special ranges):
   $\pm$ 5% (of full scale) $\pm$ 1/2 DN

d. Other Analog Measurements:
   $\pm$ 1% (of full scale) $\pm$ 1/2 DN

3.4 Data Transmission

The GLL Orbiter shall be capable of data transmission under one or more of the following basic modes:

a. To the Shuttle Orbiter (via IUS) for downlink by the Shuttle Orbiter.

b. To the IUS for downlink by the Shuttle Orbiter (with concatenated Shuttle Orbiter and IUS data).

c. To the IUS for downlink by the IUS (with concatenated IUS data).

d. To the Tracking Data Relay Satellite (TDRS).

e. Via a low-rate channel over S-band.

f. Via a high-rate channel over S or X-band.

3.4.1 STS Attached Phase

The GLL Orbiter data shall be provided via a hardline to both: (1) the IUS at 1.2 kb/s for inclusion in the IUS/Shuttle Orbiter data stream and (2) the Shuttle Orbiter at 1.2 kb/s. The S/C data stream shall be from the CDS and shall not be convolutionally coded. The CDS shall enable/inhibit the serial telemetry to the IUS and Shuttle Orbiter based on the logical state of one of the despun bilevel inputs. See Table A2.2.9.

3.4.2 STS Detached Phase

3.4.2.1 Data Through S/C Direct to TDRS. During this phase, the GLL Orbiter shall transmit GLL Orbiter data to the TDRS at 1200 b/s for relay to earth. This transmission shall be convolutionally coded (rate = 1/2, constraint length = 7; 2400 symbols per second) with no subcarrier.

3.4.2.2 Data Through IUS. During this phase the GLL Orbiter shall send GLL Orbiter data at 1200 b/s to the IUS for transmission to the earth. This transmission shall be uncoded.

3.4.3 Low-Rate Channel

The low-rate channel (40 b/s only) shall function on S-band only and shall contain real-time low-rate engineering data exclusively. It shall be possible to remove low-rate channel telemetry modulation from the downlink by CDS command to the MDS. The low-rate channel shall be uncoded. It shall be possible to transmit low-rate engineering simultaneously with any other data on the high-rate channel provided the low-rate channel is transmitted on the S-band downlink and the high-rate channel on the X-band downlink.

3.4.4 High-Rate Channel

The high-rate channel shall be the primary mode of data transmission during the mission. This channel may contain any of the following types of data after the completion of launch operations:

a. Low-Rate Science (LRS).

b. Medium-Rate Science (MRS) which includes LRS, NIMS and either PRB or PWS data.

c. Intermediate-Rate Science (XRS) which includes LRS, NIMS, and SSI or PWS data.

d. High-Rate Science (HRS) which includes LRS, NIMS, and either SSI or PWS data.

e. LRS with or without NIMS with embedded S/C tape recorded playback data.

f. 10 b/s Engineering.

g. 1200 b/s Engineering.

h. S-band Back-up Science (BUS)

i. Engineering data to TDRS (paragraph 3.4.2.1) (no subcarrier).

j. 40 b/s Engineering.

It shall be possible to remove high-rate channel telemetry modulation from the downlink by CDS command to the MDS. The telemetry rates and modes available on the high rate channel shall be as specified in paragraph 3.8 herein.

All data on the high-rate channel shall employ a constraint length = 7, rate = 1/2 convolutional code and the channel shall operate on either S- or X-band. Transition density requirements shall be met in order to permit Ground decoding as specified in GLL-3-300, Telecommunications and GLL-3-100, Requirements and Constraints.

3.5 Data Processing

The GLL Orbiter contains a number of on-board computers, peripheral processors and analog or digital interfaces. Collectively these computers, processors, and interfaces shall be defined as the GLL Orbiter data system. Each of the on-board processors shall be assigned dedicated functions described in the following paragraphs and in GLL-3-310, Software Requirements.

3.5.1 Science Subsystem Processor Telemetry Functions

Except for selected subsystem temperature measurements processed by the CDS, each science subsystem shall be responsible for its data collection, analog to digital (A/D) conversion, processing, formatting, and buffering. The instrument data shall be output under control of the CDS.
General science subsystem telemetry data requirements shall include the following items:

a. All status/housekeeping data needed to monitor the subsystem status and sequence performance in real-time shall be placed at the start of the subsystem's bit allocation in each telemetry frame and shall have a deterministic relationship to the spacecraft clock.

b. Science sensor data shall be output in at least one known format within the instruments bit allocation.

c. The low rate science data frame shall include status information for all science instruments (including the high rate science instruments whose data may not exist in the low rate science frame).

d. Each science instrument shall output sufficient status/housekeeping to determine all critical and/or controllable instrument performance states or parameters (including mode, memory checksums, processor self-test results, counters for commands accepted, bus parity errors detected, rejected commands, entries to fault routines, last command received, time of last sync discrepancy, voltages, currents, power on reset). All status values shall represent an absolute value (rather than change).

   All mode identification status shall precede or be concurrent with the output of the sensor data to which it refers.

e. Instrument data taking cycles shall be governed by and synchronous to the following equation:

$$n \; t_s = m \; t_i$$

where:

t_s = Science instrument cycle time

t_i = Imaging (SSI) picture frame time (60-2/3 seconds)

n = 1, 2, 3 .... n
m = 1, 2, 3, 4, 5

f. All instrument data mode changes shall occur when the downlink spacecraft clock MOD 91 is 0, 13, 26, 39, 52, 65, or 78 and the MOD10, and MOD8 are both zero. The data contained within the instrument downlink allocation shall be valid for the new mode beginning concurrently with the change to the new mode.

3.5.2 <u>AACS Processor Telemetry Functions</u>

Except for selected subsystem temperature measurements processed by the CDS, the AACS shall be responsible for its data collection, A/D conversion, processing, formatting and buffering. The AACS data shall be output under control of the CDS from a buffer area in AACS memory. The data in this buffer will be updated once each minor frame (2/3 seconds) during RTI 0. The data contained in the buffer will include Low Rate Science (LRS) telemetry, fixed telemetry, and variable packet telemetry. The LRS data shall consist of the rotor and platform pointing vectors in Earth Mean Equator 1950.0 coordinates, rotor spin position angle in Ecliptic 1950.0 coordinates, cone and clock position in spacecraft relative coordinates, the rotor spin rate, and platform cone and cross cone rates. The LRS data shall be predicted ahead to the correct value for RTI 0.

3.5.3 <u>CDS Processor Telemetry Functions</u>

3.5.3.1 <u>General.</u> The CDS shall be responsible for the A/D conversion of all analog measurements, sampling digital and bi-level measurements attached to the CDS; collection, conversion, buffering, formatting CDS telemetry data; source error protection (Golay coding); collecting and formatting other subsystem data into telemetry frames for transmission to the DMS and/or to earth as specified in paragraph 3.8.

The CDS shall output sufficient information such that detailed bit-level ground simulation of on-board events are not required for spacecraft sequencing or ground analysis of on-board activity.

3.5.3.2 <u>Command Accountability.</u> The following requirements shall apply to command transmission both from the ground to the Orbiter (Uplink) and from the CDS to the other subsystems (Onboard).

3.5.3.2.1 Uplink command accountability

a) The following information about the last message received at the CDS shall be inserted into the downlink at least once every 60 2/3 seconds:

1. Message number.
2. Message type.
3. Number of frames in message.
4. Presence or absence of start word error.
5. acceptance or rejection of message.

b) In Orbiter system test, an echo of each uplink command bit shall be sent from the CDS to the CDS support equipment.

c) Separate 8-bit counters for each function described below shall be downlinked at least once every 60 2/3 seconds:

1. Uplink messages received and accepted (1 counter for each message type).
2. Uplink messages received and rejected.
3. Command frames detected in error.
4. Data frames corrected.
5. Uncorrectable data frames.
6. DAC rejected because of elapsed time.
7. DAC rejected because of invalid message number.
8. DAC rejected because of occupied buffer slot.
9. CDU lock changes.

d) The active/inactive status of each DAC buffer slot shall be indicated in the downlink at least once every 60 2/3 seconds.

e) The most recently commanded state of CDS critical controller registers and critical enable relays shall be placed in the downlink at least once every 60 2/3 seconds.

f) A list of messages found missing by the CDS from the last message sequence shall be downlinked at least once every 60 2/3 seconds, or upon receipt of the terminator message of the message sequence.

3.5.3.2.2 Orbiter (Onboard) command accountability shall consist of:

1) Periodic readout counters for each of the following:

a) Number of commands issued from stored CDS sequences
b) Number of Real Time Commands
c) Number of commands resulting from interactive requests from other Orbiter subsystems (i.e., error correction routines and alarms)
d) Number of power code commands.
e) Heart beat

NOTE: counters must count commands as they are issued by the CDS

2) Identification of executing sequence elements.

3) Buffer for downlink transmission of the latest 16 commands distributed consisting of CCs, DCs, PCs, and the first four bytes of BCs issued to another subsystem. Prepared commands, spacecraft time and sector data commands shall not be buffered. Command activity which exceeds the buffering capability shall overwrite the oldest nontransmitted command.

Error routine commands shall be included in the 16 buffer and shall be given priority over the other commands. There is no requirement to specially format or add fill for CC or DC commands. However, to ensure that commands are not written before downlinking, a lockout function shall be implemented when reading out a command. Commands from the active or primary HLM shall be input to the 16 command buffer unless a critical sequence is being executed from both HLMs, in which case commands from both HLMs should be input to the buffer.

3.5.4 Data Forms

Data shall be presented to the CDS in either analog or digital form. Digital data may consist of discrete event pulses, bi-levels, or serial Non-Return to Zero (NRZ) data; except for data provided to the CDS over the data bus which shall be serial Return to Zero (RZ), and data sent to the CDS from the PWS and SSI via the high speed interfaces where the serial stream is split between two lines with data appearing in RZ format on each. Analog data shall consist of variable voltages. All analog engineering data shall be consistent with the ranges specified in paragraph 3.3 for the appropriate transducer. Data presented to the MDS or DMS shall be in the form of serial NRZ data, MSB first.

Data presented to the CDS as analog voltages shall be converted to 8-bit digital words with leading zeros where the data does not fill all 8 bits.

All status data shall represent absolute value (rather than change to previous value).

3.6 Source Error Protection Coding

The CDS shall provide the capability to code portions of the LRS data and the Probe data transmitted on the high-rate channel using a Golay (24, 12) code interleaved to depth 36. This interleaving scheme shall be as defined in paragraph 3.6.3. LRS shall be Golay coded except for UVS and engineering data. HRS data shall not be Golay coded.

3.6.1 Golay Coding Function

The Golay code, together with a K=7, R=1/2 convolutional code, is employed to construct a concatenated high-rate data channel which simultaneously satisfies two different science data bit error rate requirements. Selected science data is Golay coded prior to being time multiplexed with non-Golay coded imaging, NIMS, or PWS data not in the LRS frame. The performance of the code is such that, after being decoded, certain portions of the LRS data will be delivered to the users with a bit error rate of $\leq 5 \times 10^{-5}$ even though the overall high rate channel is operated at a bit error rate of $\leq 5 \times 10^{-3}$.

3.6.2 Code Operation

The Golay (24, 12) code transforms a set of 12 data bits into a Golay code word comprised of 24 binary code symbols. The first 12 symbols of a Golay code word are identical to the 12 original data bits whereas the last 12 symbols of the Golay code word are a linear function of the 12 data bits. The code has the property that any combination of ≤ 3 symbol errors in a Golay code word can be exactly corrected and the occurrence of exactly 4 symbol errors can be unequivocally detected. [If > 4 symbol errors occur in a received Golay code word, the decoding processes will, in general, produce additional bit errors].

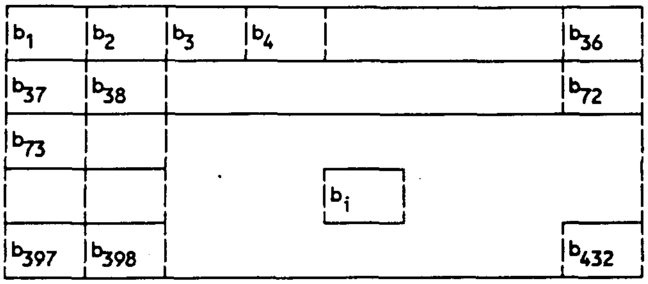
3.6.3 Interleaving Depth

The high-rate channel design employs a convolutional code which is concatenated with the Golay code. The characteristic of the convolutional decoding process is that errors in the high-rate channel stream tend to occur in bursts. For this reason, blocks of Golay words (36 words per block) are interleaved on a bit-by-bit basis to provide increased protection against these burst errors. The interleaving process is shown in Figure 2. Note that despite the interleaving process, the first 432 symbols of the Golay code block are identical to the original 432 data bits. The net effect of this interleaving process (referenced to as "interleaving to depth 36") is that the length of burst error must be greater than 108 bits before the error correction properties of the Golay code are exceeded.

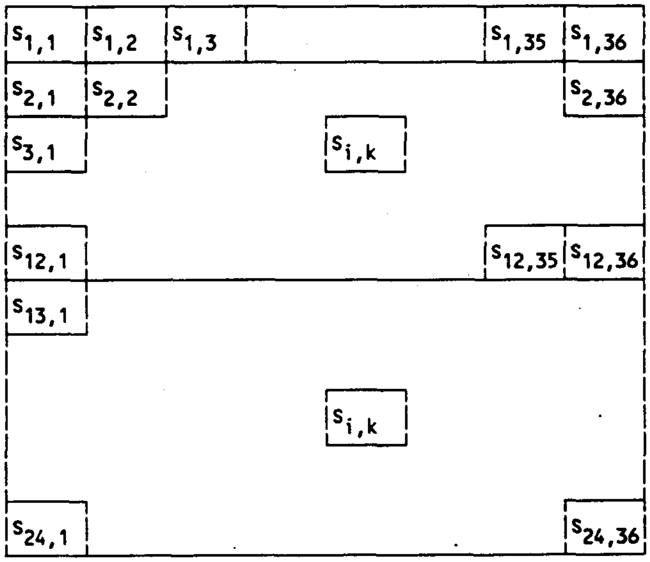
3.7 Data Storage

Data storage (DMS) shall be provided by a single digital tape recorder whose capacity is 9×10^8 bits.

In order to simplify the ground tape management tasks associated with the S/C tape recorder, all data recording and playback of the data shall occur in the same tape direction (First In, First Out). The data from the tape recorder shall appear to the ground as if it were a normal, real-time data stream (e.g., no backwards data; no parallel record with serial playback).



ORIGINAL (UNCODED) DATA SET



ASSOCIATED GOLAY CODE BLOCK

NOTES:

1. DATA SEQUENCE IS LEFT-TO-RIGHT BY TOP-TO-BOTTOM

2. b_i DENOTES THE i^{TH} BIT IN A SEQUENCE OF 432 DATA BITS

3. $S_{I,K}$ DENOTES THE i^{TH} CODE SYMBOL OF THE K^{TH} CODE WORD OF AN 864 SYMBOL GOLAY CODE BLOCK

   (i TAKES ALL INTEGER VALUES FROM 1 TO 24 AND k TAKES ALL INTEGER VALUES FROM 1 TO 36)

4. EACH COLUMN IN THE GOLAY CODE BLOCK IS A GOLAY CODE WORD

5. THE FIRST 432 SYMBOLS OF THE GOLAY CODE BLOCK ARE IDENTICAL TO THE ORIGINAL DATA BITS:

   $S_{1,1} = b_1$

   $S_{1,2} = b_2$

   $\vdots$

   $S_{2,1} = b_{37}$

   ETC.

6. DATA IS ENCODED S_{ik} WHERE

   $1 \le i \le 24$ FOR EACK K IN RANGE 1,36

7. DATA IS TRANSMITTED IN THE DOWNLINK S_{ik} WHERE

   $1 \le k \le 36$ FOR EACH i IN RANGE 1,24

3.7.1 Data Recording

The DMS shall be capable of recording at any of the following data rates on command from the CDS.

a) 806.4 kb/s

b) 403.2 kb/s

c) 115.2 kb/s

d) 28.8 kb/s

e) 7.68 kb/s

3.7.2 Data Playback

The DMS shall be capable of playing back data to the CDS at any of the following rates on command from the CDS.

a) 100.8 kb/s

b) 57.6 kb/s

c) 19.2 kb/s

d) 7.68 kb/s

3.8 Telemetry Modes and Rates

The telemetry modes and data rates shall be as shown in Table 1. The table shows the real-time telemetry frame name and downlink telemetry rate, and the recorded telemetry frame name along with its associated recording rate.

Bits 1-5 of the Format Identification (FID) represent the assignment of the real-time telecommunication rate and frame format. Bits 12-16 of the FID represent the assignment of the recorded telecommunications rate and frame format. Taken together, these two fields uniquely identify the telemetry mode.

The basic GLL bit rate allocations within each format shall be as shown in Table 3.

Table 1. GLL Telemetry Modes
Real-Time Formats

Mnemonic	Downlink Data Rate	Primary Data Type	Bits 1-5 of FID	Reference Paragraph
NONE	N/A	No data being downlinked	N/A	N/A
		<u>Engineering</u>		
ELS	10 bps	10 bps snapshot of 1200 bps engineering data	1 1 1 1 0	3.9.3
ESS	40 bps	40 bps snapshot of 1200 bps engineering data	1 1 1 0 1	3.9.3
EHR	1200 bps	Engineering data at 1200 bps	0 0 0 0 1	3.9.3
		<u>Low Rate Science</u>		
LPB	7.68 Kbps	Tape recorder playback at 7.68 Kbps	0 0 0 0 0	N/A
LRS	7.68 Kbps	Low Rate Science at 7.68 Kbps	1 0 0 1 1	3.9.4
		<u>Medium Rate Science</u>		
MPB	28.8 Kbps	Tape recorder playback at 19.2 Kbps, with LRS at 7.68 Kbps	0 0 0 1 1	3.9.6
MPW	28.8 Kbps	PWS data at 7.68 Kbps, with NIMS at 11.52 Kbps, and LRS at 7.68 Kbps	1 0 1 0 0	3.9.5
MPP	28.8 Kbps	PWS data at 19.2 Kpbs, with LRS at 7.68 Kbps	0 1 1 1 0	3.9.5A
MPR	28.8 Kbps	Probe/RRH data at 7.68 Kbps, with NIMS at 11.52 Kbps, and LRS at 7.68 Kbps	0 1 1 1 1	3.9.20
		<u>Intermediate Rate Science</u>		
XPB	67.2 Kbps	Tape recorder playback at 57.6 Kbps, with LRS at 7.68 Kbps	0 0 1 1 1	3.9.10
XPW	67.2 Kbps	PWS data at 45.56 Kbps, with NIMS at 11.52 Kbps, and LRS at 7.68 Kbps	0 0 1 0 0	3.9.9

Table 1. GLL Telemetry Modes
Real-Time Formats

Mnemonic	Downlink Data Rate	Primary Data Type	Bits 1-5 of FID	Reference Paragraph
XCM	67.2 Kbps	Imaging data compressed to 38.88 Kbps, with NIMS at 11.52 Kbps, LRS at 7.68 Kbps	0 0 1 0 1	3.9.8
XED	67.2 Kbps	Imaging data compressed and edited to 38.88 Kbps, with NIMS at 11.52 Kbps, and LRS at 7.68 Kbps	0 0 1 1 0	3.9.7
XRW	80.64 Kbps	PWS data at 46.56 Kbps, with NIMS at 11.52 Kbps, and LRS at 7.68 Kbps	0 1 0 0 1	3.9.10A
XPN	80.64 Kbps	Tape recorder playback at 57.6 Kbps, with NIMS at 11.52 Kbps, and LRS at 7.68 Kbps	0 1 0 0 0	3.9.10B
		<u>High Rate Science</u>		
HPB	115.2 Kbps	Tape Recorder playback at 100.8 Kbps, with LRS at 7.68 Kbps	0 1 0 1 0	3.9.14
HPW	115.2 Kbps	PWS data at 94.56 Kbps, with NIMS at 11.52 Kbps, and LRS at 7.68 Kbps	1 0 0 0 0	3.9.13
HIM	115.2 Kbps	Imaging data at 94.56 Kbps, with NIMS at 11.52 Kbps, and LRS at 7.68 Kbps	1 0 0 0 1	3.9.11
HCM	115.2 Kbps	Imaging data compressed to 77.76 Kbps, with NIMS at 11.52 Kbps, and LRS at 7.68 Kbps	1 0 0 1 0	3.9.12
HCJ	134.4 Kbps	Imaging data compressed to 77.76 Kbps, with NIMS at 11.52 Kbps, LRS at 7.68 Kbps, and PWS at 12.96 Kbps	0 1 1 0 1	3.9.12A
HRW	134.4 Kbps	PWS data at 94.56 Kbps, with NIMS at 11.52 Kbps, and LRS at 7.68 Kbps	0 1 1 0 0	3.9.14A

Table 1. GLL Telemetry Modes
Real-Time Formats

Mnemonic	Downlink Data Rate	Primary Data Type	Bits 1-5 of FID	Reference Paragraph
HPJ	134.4 Kbps	Tape recorder playback at 100.8 Kbps, with NIMS at 11.52 Kbps, LRS at 7.68 Kbps and PWS at 12.96 Kbps	0 1 0 1 1	3.9.14B
		<u>Miscellaneous</u>		
BPB	16.8 Kbps	Tape recorder playback at 7.68 Kbps, LRS at 7.68 Kbps	0 0 0 1 0	3.9.19
KPR	40 bps	Keep-alive power on reset mode (alternate 1's and 0's)	N/A	3.9.21
LMF	600 bps	Keep-alive power on reset mode during launch (consists of indeterminate data)	N/A	3.9.22

Table 1. GLL Telemetry Modes
Record Formats

Mnemonic	Data Rate to DMS	Primary Data Type	Bits 12-16 of FID	Reference Paragraph
NONE	N/A	No data being recorded	0 0 0 0 0	N/A
		<u>Low Rate Science</u>		
LRS	7.68 Kbps	Low Rate Science at 7.68 Kbps	1 0 0 1 1	3.9.4
		<u>Medium Rate Science</u>		
MPW	28.8 Kbps	PWS data at 7.68 Kbps, with NIMS at 11.52 Kbps, and LRS at 7.68 Kbps	1 0 1 0 0	3.9.5
MPP	28.8 Kbps	PWS data at 19.2 Kbps, with LRS at 7.68 Kbps	0 1 1 1 0	3.9.5A
MPR	28.8 Kbps	Probe/RRH data at 7.68 Kbps, with NIMS at 11.52 Kbps, and LRS at 7.68 Kbps	0 1 1 1 1	3.9.20

Table 1. GLL Telemetry Modes
Record Formats

Mnemonic	Data Rate to DMS	Primary Data Type	Bits 12-16 of FID	Reference Paragraph
		High Rate Science		
HPW	115.2 Kbps	PWS data at 94.56 Kbps, with NIMS at 11.52 Kbps, and LRS at 7.68 Kbps	1 0 0 0 0	3.9.13
HIM	115.2 Kbps	Imaging data at 94.56 Kbps, with NIMS at 11.52 Kbps, and LRS at 7.68 Kbps	1 0 0 0 1	3.9.11
HCM	115.2 Kbps	Imaging data compressed to 77.76 Kbps, with NIMS at 11.52 Kbps, and LRS at 7.68 Kbps	1 0 0 1 0	3.9.12
IM4	403.2 Kbps	Imaging data compressed to 311.04 Kbps, with NIMS at 11.52 Kbps, and LRS at 7.68 Kbps	1 1 0 0 1	3.9.17
PW4	403.2 Kbps	PWS data at 372.48 Kbps, with NIMS at 11.52 Kbps, and LRS at 7.68 Kbps	1 1 0 0 0	3.9.18
IM8	806.4 Kbps	Imaging data at 768 Kbps, with NIMS at 11.52 Kbps, and LRS at 7.68 Kbps	1 0 1 1 0	3.9.15
AI8	806.4 Kbps	Imaging data averaged to 768 Kbps, with NIMS at 11.52 Kbps, and LRS at 7.68 Kbps	1 0 1 1 1	3.9.15A
PW8	806.4 Kbps	PWS data at 768 Kbps, with NIMS at 11.52 Kbps, and LRS at 7.68 Kbps	1 0 1 0 1	3.9.16

Table 2. Allowable Combinations of
Real-time and Record Formats

R/T Format	Rec Format
ESS	None, LRS, MPR, HPW, HIM, HCM, IM4, PW4, IM8, PW8, MPP, MPW, AI8
ELS	None, LRS, MPR, HPW, HIM, HCM, IM4, PW4, IM8, PW8, MPW, MPP, AI8, NCG
EHR	None, LRS, MPR, HPW, HIM, HCM, IM4, PW4, IM8, PW8, MPP, MPW, AI8
LPB	None
LRS	None, LRS, HIM, HCM, HPW, IM4, PW4, IM8, PW8, AI8, NCG
MPB	None
MPW	None, MPW
MPP	None, MPP
MPR	None, MPR
XPB	None
XPW	None, HIM, HCM, IM4, IM8, AI8, NCG
XCM	None, HPW, PW4, PW8, NCG
XED	None, HPW, PW4, PW8, NCG
XPN	None
XRW	None, HIM, HCM, IM4, IM8, AI8, NCG
HPB	None
HPW	None, HIM, HCM, IM4, IM8, HPW, AI8, NCG
HIM	None, HPW, PW4, PW8, HIM, NCG
HCM	None, HPW, PW4, PW8, HCM, NCG
HCJ	None
HPJ	None
HRW	None, HIM, HCM, IM4, IM8, HPW, AI8, NCG
BPB	None
None*	LRS, MPW, HIM, HCM, HPW, IM4, PW4, IM8, PW8, AI8
KPR	None
LMF	None
NCG	None, HIM, HCM, IM4, IM8, AI8, HPW, PW4, PW8

* Downlink telemetry data is not radiated from S/C. Modulation is removed in MDS TMU output units.

3.8.1 Engineering Telemetry Modes

It shall be possible (1) to acquire engineering data at 1200 b/s, (2) to transmit engineering data at 10, 40, or 1200 b/s rates, and (3) to record engineering data at 1200 b/s by using the standard LRS frame.

The 1200 b/s engineering-only mode shall be used during launch operations when the orbiter data is being included in the Shuttle or IUS data stream and when the TDRS is tracking the GLL S/C. It shall be possible to use this data stream mode during cruise operations.

The 1200 b/s engineering data shall be available as a part of the LRS data. It shall be used during maneuvers, system testing, performance monitoring and aiding in the diagnosis of inflight anomalies.

It shall be possible to transmit at 40 b/s every 30th frame of the 1200 b/s engineering. This 40 bps transmission shall be known as "snapshot" engineering. The capability to transmit the snapshot data uncoded over the S-band link shall exist continuously, and simultaneously with any other data (including convolutionally encoded snapshot data) transmitted on the X-band link. The capability to transmit the snapshot data convolutionally encoded over the S-band and X-band links shall be available using real time commands from the ground.

It shall be possible to transmit at 10 b/s every 120th frame of the 1200 b/s engineering. This 10 b/s transmission shall be known as "Engineering Low Rate Snapshot". The 10 b/s coded telemetry will be transmitted over the high rate channel to the MDS. The capability to transmit the engineering data at 10 b/s shall be available using real time commands from the ground.

In those cases where EHR or ESS or ELS is being transmitted at a real time rate of 1200 b/s, 40 b/s, or 10 b/s respectively, there shall be an option to :

a: Record the real time LRS
b: Record LRS, NIMS and SSI at 115.2, 403.2 or 806.4 kbps
c: Record LRS, NIMS and PWS at 115.2, 403.2 or 806.4 kbps
d: Record Probe/RRH at 7.68 kbps, with NIMS at 11.52 kbps and LRS at 7.68 kbps
e: Record MPW, MPP, and AI8.

3.8.2 <u>Memory Readout.</u>

Memory readout shall be accomplished by replacing a portion of the variable area data in the Engineering frame with any of the following: CDS memory readout data, the attitude and articulation control subsystem (AACS) memory data or the science subsystem memory data. The CDS memory can contain 7.68 kbps DMS playback data.

3.8.3 <u>Science Telemetry Modes</u>

The Galileo Orbiter shall be capable of operation in the science telemetry modes as described in the following paragraphs. The various options are shown in Table 1 and 2.

3.8.3.1 <u>Low-Rate Science (LRS).</u>

The LRS telemetry mode containing the fields and particles experiment data shall be transmitted at a real-time data rate of 7.68 kb/s and shall be included in real-time telemetry modes exceeding 7.68 b/s: HRS, MRS, XRS, and BUS telemetry modes. LRS data shall contain engineering data at 1200 b/s. Selected portions of the LRS data shall be Golay coded whenever it is transmitted in real-time, recorded on the DMS, or incorporated into other higher rate science frames.

In those cases where LRS is being transmitted at a real-time rate of 7.68 kb/s, there shall be options to:

a. Record the real-time LRS
b. Record LRS, NIMS, and SSI at 115.2, 403.2 or 806.4 kbps
c. Record LRS, NIMS, and PWS at 115.2, 403.2 or 806.4 kbps

3.8.3.2 Medium-Rate Science (MRS). The MRS telemetry mode shall be used for (1) Probe checkout or entry data or (2) PWS waveform data at a data rate of 7.680 kb/s. MRS data shall contain LRS and NIMS data. It shall be transmitted in real-time and recorded on the DMS for probe entry data, and optionally recorded on the DMS for the PWS data or probe checkout data.

3.8.3.3 Intermediate-Rate Science (XRS). The XRS telemetry mode shall nominally be used to replace HRS when the telecommunications performance will not support 115.2 kb/s. The data rate for these modes shall be 67.2 kb/s or 80.64 kb/s.

The header, LRS, and NIMS bit allocations shall be identical to the HRS frames. The PWS or SSI data shall be included but at a reduced rate. SSI data shall be edited or compressed.

In those cases where XRS is being transmitted in real-time, there shall be options to:

a. While transmitting PWS, record SSI data at 115.2, 403.2, and 806.4 kb/s.
b. While transmitting SSI, record PWS data at 115.2, 403.2, and 806.4 kb/s.

3.8.3.4 High-Rate Science (HRS). The HRS telemetry modes shall be capable of being transmitted at a real-time data rate of 115.2 kb/s or 134.4 kb/s. These telemetry modes shall be common in that each contains LRS data at 7.68 kb/s, NIMS data at 11.52 kb/s and either PWS or SSI at 94.56 kb/s.

In those cases where HRS is being transmitted in real time, there shall be options to:

a. While transmitting PWS, to record PWS at 115.2 kb/s or record SSI at 115.2, 403.2, or 806.4 kb/s.
b. While transmitting SSI, to record SSI at 115.2 kb/s or record PWS at 115.2, 403.2, or 806.4 kb/s.

3.8.3.5 Deleted

3.8.3.6 S-band Back-up Science (BUS). The BUS telemetry modes shall provide reduced science data-return capability in the event of loss of X-band downlink. These telemetry modes shall provide real time LRS and other TBD elements. One option shall provide a DMS playback.

Table 3. GLL Bit Rate Allocations (kb/s)

Frame	Frame Rate (kb/s)	May be Recorded	ENG	LRS(2)	NIMS	SSI	Reed-Solomon	PWS	PRB	Filler	Playback
EHR	1.20	No (4)	1.20	--	--	--	---	---	---	---	0.384 (3,5)
ESS	.040	No	.040	--	--	--	---	---	---	---	0.0128 (3,5)
ELS	.010	No	.010	--	--	--	---	---	---	---	----
LRS	7.68	Yes	(1)	7.68	--	--	---	---	---	---	----
MPW	28.8	Yes	(1)	7.68	11.52	--	---	7.68	---	0.48	----
MPP	28.8	Yes	(1)	7.68	--	--	---	19.20	---	0.48	----
MPR	28.8	Yes	(1)	7.68	11.52	--	---	---	6.48	1.68	----
MPB	28.8	No	(1)	7.68	--	--	---	---	---	0.48	19.2 (3)
XED	67.2	No	(1)	7.68	11.52	38.88	7.68	---	---	---	----
XCM	67.2	No	(1)	7.68	11.52	38.88	7.68	---	---	---	----
XPW	67.2	No	(1)	7.68	11.52	--	---	46.56	---	---	----
XPB	67.2	No	(1)	7.68	--	--	---	---	---	0.48	57.6 (3)
XRW	80.64	No	(1)	7.68	11.52	--	---	46.56	---	13.44	----
XPN	80.64	No	(1)	7.68	11.52	--	---	---	---	2.4	57.6 (3)
HIM	115.2	Yes	(1)	7.68	11.52	94.56	---	---	---	---	----
HCM	115.2	Yes	(1)	7.68	11.52	77.76	15.36	---	---	1.44	----
HPW	115.2	Yes	(1)	7.68	11.52	--	---	94.56	---	---	----
HPB	115.2	No	(1)	7.68	--	--	---	---	---	5.28	100.8 (3)
HCJ	134.4	No	(1)	7.68	11.52	77.76	15.36	12.96	---	7.68	----
HRW	134.4	No	(1)	7.68	11.52	--	---	94.56	---	19.2	----
HPJ	134.4	No	(1)	7.68	11.52	--	---	12.96	---	---	100.8 (3)
IM8	806.4	Yes	(1)	7.68	11.52	768.00	---	---	---	7.68	----
AI8	806.4	Yes	(1)	7.68	11.52	768.00	---	---	---	7.68	----
PW8	806.4	Yes	(1)	7.68	11.52	--	---	758.00	---	7.68	----
IM4	403.2	Yes	(1)	7.68	11.52	311.04	61.44	---	---	---	----
PW4	403.2	Yes	(1)	7.68	11.52	--	---	372.48	---	---	----
BPB	16.8	No	(1)	7.68	--	--	---	---	---	---	7.68 (3)

NOTES:
(1) Included in the LRS allocation.
(2) Detailed allocation shown in paragraph 3.9.4.
(3) Contains whatever was previously recorded on the DMS.
(4) Since it is included in the LRS frame, recording LRS records ENG.
(5) When "MRO Playback", i.e. Playback by Memory Read-out, is enabled.

3.8.4 Playback (PB)

Except for the 7.68 kb/s downlink playback rate (which has no real-time LRS data), the Galileo PB telemetry modes shall be comprised of real-time LRS data at 7.680 kb/s, with or without NIMS at 11.52 kb/s, and the contents of the DMS. The playback telemetry modes shall be downlinked at any of the following rates: 7.68, 16.8, 28.8, 67.2, 80.64, 115.2 or 134.4 kb/s. During playback the DMS contents shall be downlinked without any modification. The 7.68 kbps DMS playback data can be copied into CDS memories and downlinked via memory readout.

3.9 Telemetry Data Formats

3.9.1 General

The GLL telemetry frames shall be structured in accordance with the NASA Planetary Data Standards; specifically,

a. All frame lengths shall be multiples of 16 bits.
b. All data subsets within the frame shall be multiples of 8 bits. Unused bits shall be zero filled with the data portion right justified within the field.
c. The frame synchronization code shall be 32 bits.
d. Convolutional Code (K = 7, R = 1/2) shall be used.
e. Experimental convolutional Code (K=15, R=1/4) may be used during portions of the mission.

In an attempt to retain flexibility to change bit rate allocations among the various GLL subsystems, a generalized concept of specifying the format contained within the frame is being used. This concept separately documents each subsystem allocation in the frame. Each of these allocations is then concatenated to create the resultant frame as seen in the downlink telemetry stream. All Orbiter and ground software shall be designed to easily accommodate changes to allocations and position in the downlink telemetry frame.

3.9.2 Header

The first 96 bits of each telemetry frame except KPR shall consist of those necessary fields which enable frame synchronization, identification and decommutation of the received data. The format of the header is shown in Figure 3 and described in greater detail by Table 4. The individual fields are described in paragraph 3.9.2.1 through 3.9.2.3. The KPR exception is described in paragraph 3.9.21.

FRAME SYNCHRONI-ZATION CODE (FSC)	FORMAT IDENTIFI-CATION (FID)	SPACECRAFT CLOCK (SCLK)
32	16	48

Figure 3. Header

Table 4. Header Format

Data Description	Bits Frame	Offset to Data Start	Paragraph
Frame Synchronization Code	32	0	3.9.2.1
Format Identification	16	32	3.9.2.2
Spacecraft Clock	48	48	3.9.2.3

3.9.2.1 Frame Synchronization Code (FSC). The frame synchronization code shall be comprised of 32 bits with the following pattern:

MSB
(Binary) 0000 0011 1001 0001 0101 1110 1101 0011
(Hexadecimal) 03915ED3

3.9.2.2 Format Identification (FID). Each telemetry frame shall contain a format identification word which identifies the data being processed and transmitted from the Orbiter. All data within the frame shall be completely and unambiguously identifiable by the format identification, the S/C clock, and the pre-established frame commutation sequence.

The data output concurrently with the change of the FID shall be immediately valid.

The structure of the FID is shown in Figure 4 and described in greater detail in Table 5.

3.9.2.2.1 Real-time Identifier (R/T). Bits 1 through 5 shall indicate the real-time downlink rate and format, as shown in Table 1. On all data being placed onto the DMS, this field shall contain all zeros. The real time identifier shall be permitted to change only when the MOD91 count is 0, 13, 26, 39, 52, 65, or 78 and the MOD10 and MOD8 counts are zero.

Real-time Identifier	Memory Readout	Commutation Map Identifier	Map Sequence Number	Record Identifier
5	1	2	3	5

Figure 4. Format Identification

Table 5. Format Identification

Data Description	Bits Allocated	Offset to Data Start	Paragraph
Real-time identifier	5	0	3.9.2.2.1
Memory Readout	1	5	3.9.2.2.2
Commutation Map Identifier	2	6	3.9.2.2.3
Map Sequence Number	3	8	3.9.2.2.4
Record Identifier	5	11	3.9.2.2.5

3.9.2.2.2 <u>Memory Readout (MRO)</u>. Bit 6 of the FID shall identify the fact that memory readout data has replaced the first 7 variable engineering packets.

0 = Variable engineering is present
1 = Memory readout data is present

The MRO bit shall be set to 1 only concurrently with the start of a real-time imaging cycle (RIM). The MRO bit may be reset to zero at any time.

3.9.2.2.3 <u>Commutation Map Identifier (CMI)</u>. Bits 7 and 8 shall identify the commutation map currently being used to sample the S/C engineering subsystem data. The assignment of these bits shall be as shown in Table 6.

The actual assignment of the mission phase commutation maps shall be to one of the four available map allocations. The commutation map shall identify the variable engineering packets, their timing relationships, and their placement into the engineering format. The details of these commutation maps are found in paragraph A2.2.

In the event that any on-board detected anomaly occurs which is permitted to cause automatic changing of commutation maps, the change shall be to map 0.

The CMI shall change only concurrently with the start of a RIM cycle.

Table 6. Commutation Map Identifier (CMI) Assignment

Bits 7,8	Commutation Map Identifier	Assigned Map Purpose
00	0*	Anomaly Investigation
01	1	Calibration
10	2	Maneuvers
11	3	Cruise/Encounter/ Orbital Operations

*This CMI shall be used for any on-board detected anomaly which causes an automatic CMI change.

3.9.2.2.4 Map Sequence Number (MSN). Bits 9 through 11 shall represent the number of times the specified commutation map (in bits 7-8) has changed since the map was loaded in the S/C memory.

The contents of this field shall increment by one each time the map is used to transmit data in real-time where one or more changes have occured since the last use of the map. The MSN shall change only concurrently with the start of a RIM cycle.

3.9.2.2.5 Record Identifier (REC). Bits 12 through 16 shall indicate the rate and format of data being placed on to the DMS, as shown in Table 1. In the event there is no data being placed on the tape recorder, this field will contain all zeros. The Record Identifier shall be permitted to change only when the MOD91 count is 0, 13, 26, 39, 52, 65, or 78 and the MOD10 and MOD8 counts are zero.

3.9.2.2.6 R/T and REC Allowable Combinations. Allowable combinations of real-time and record identifiers are shown in Table 2.

3.9.2.3 Spacecraft Clock (SCLK). Each GLL telemetry frame shall contain a S/C time field. The SCLK shall have the characteristic that it can be directly used to determine time, identify all measurements, and to correlate events to within the time resolution of the S/C clock.

The SCLK shall mark the first bit of the frame synchronization code time and shall represent the time interval in which the CDS collected the instrument data contained within the frame. The SCLK is shown in Figure 5 and is described in paragraphs 3.9.2.3.1 through 3.9.2.3.4.

1–24	25–32	33–40	41–48
REAL-TIME IMAGE COUNT (RIM)	MOD 91 COUNT (MOD 91)	MOD 10 COUNT (MOD 10)	MOD 8 COUNT (MOD 8)

Figure 5. Spacecraft Clock

3.9.2.3.1 Real-Time Image Count (RIM). This field is a 24 bit counter which shall be incremented each 60-2/3s (corresponding to a real-time image cycle). This clock shall keep unambiguous account of time for 32 years. The starting value of the counter shall be initialized at launch and shall not be reset after launch except from the ground after an interruption of power to the CDS memories. The maximum value of the SCLK shall not roll-over until attaining the value 16777215.

3.9.2.3.2 Mod 91 Count (MOD91). The MOD91 counter is an 8 bit counter which shall be incremented once every 2/3 s. This field shall range in value from 0 through 90, with 0 corresponding to the start of the real-time solid state imaging cycle. This field shall increment by one every LRS frame.

3.9.2.3.3 Mod 10 Count (MOD10). The MOD10 counter is an 8 bit counter which shall be incremented once each 66-2/3 msec. This field shall range from 0 through 9, with the change to zero synchronous to the incrementing of the MOD91 count. This field shall increment by 1 for each frame transmitted or recorded at a telemetry rate greater than 7.68 kb/s. The MOD10 count is synonymous with the Real-Time Interrupt (RTI) in the CDS.

3.9.2.3.4 Mod 8 Count (MOD8). The MOD8 counter is an 8 bit counter which shall be incremented once each 8-1/3 ms. The field shall range from 0 through 7. With the change to 0 synchronous to the incrementing of the MOD10 count.

This field shall normally be zero in any frame being created at telemetry rates less than or equaling 115.2 kb/s. For those frames being routed to the DMS at rates exceeding 115.2 kb/s, the counter shall increment by one for each frame placed onto the DMS.

Table 7. Spacecraft Clock (SCLK) Progression (cont'd)

Telemetry Rate** (kb/s)	Real-Time	Record	RIM	MOD91	MOD10	MOD8
134.4	Yes	No				
115.2	Yes	Yes	i	0	0,1,...,9	0
80.64	Yes	No	i	1	0,1,...,9	0
			.	.		
67.2	Yes	No	.	.		
			.	.		
28.8	Yes	Yes	i	90	0,1,...,9	0
16.8	Yes	No				
1.20	Yes	Yes*	i	0,1,...,90	0	0
7.68	Yes	Yes	i	0,1,...,90	0	0
			i	0	0	0,1,...7
			i	0	1	0,1,...7
			.	.	.	.
			.	.	.	.
806.4			.	.	.	.
	No	Yes	i	0	9	0,1,...7
403.2			i	1	0	0,1,...7
			.	.	.	.
			.	.	.	.
			.	.	.	.
			i	90	9	0,1,...7

* To tape recorder at 7.68 kb/s.
** 600 b/s rate (LMF mode) described in 3.9.2.3.5.

Table 7. Spacecraft Clock (SCLK) Progression (cont'd)

Telemetry Rate (kb/s)	Real-Time	Record	RIM (Modulo 30)	MOD91	MOD10	MOD8
0.040***	Yes	No	0	0,30,60,90	0	0
			1	29, 59, 89	0	0
			2	28, 58, 88	0	0
			3	27, 57, 87	0	0
			4	26, 56, 86	0	0
			5	25, 55, 85	0	0
			6	24, 54, 84	0	0
			7	23, 53, 83	0	0
			8	22, 52, 82	0	0
			9	21, 51, 81	0	0
			10	20, 50, 80	0	0
			11	19, 49, 79	0	0
			12	18, 48, 78	0	0
			13	17, 47, 77	0	0
			14	16, 46, 76	0	0
			15	15, 45, 75	0	0
			16	14, 44, 74	0	0
			17	13, 43, 73	0	0
			18	12, 42, 72	0	0
			19	11, 41, 71	0	0
			20	10, 40, 70	0	0
			21	9, 39, 69	0	0
			22	8, 38, 68	0	0
			23	7, 37, 67	0	0
			24	6, 36, 66	0	0
			25	5, 35, 65	0	0
			26	4, 34, 64	0	0
			27	3, 33, 63	0	0
			28	2, 32, 62	0	0
			29	1, 31, 61	0	0

*** KPR mode exception described in 3.9.2.3.5

Table 7. Spacecraft Clock (SCLK) Progression (cont'd)

Telemetry Rate (kb/s)	Real-Time	Record	RIM (Modulo 120)	MOD91	MOD10	MOD8
0.010	Yes	No	n + 0 *	0	0	0
			n + 1	29	0	0
			n + 2	58	0	0
			n + 3	87	0	0
			n + 5	25	0	0
			n + 6	54	0	0
			n + 7	83	0	0
			n + 9	21	0	0
			n + 10	50	0	0
			n + 11	79	0	0
			n + 13	17	0	0
			n + 14	46	0	0
			n + 15	75	0	0
			n + 17	13	0	0
			n + 18	42	0	0
			n + 19	71	0	0
			n + 21	9	0	0
			n + 22	38	0	0
			n + 23	67	0	0
			n + 25	5	0	0
			n + 26	34	0	0
			n + 27	63	0	0
			n + 29	1	0	0
			n + 30	30	0	0
			n + 31	59	0	0
			n + 32	88	0	0
			n + 34	26	0	0
			n + 35	55	0	0
			n + 36	84	0	0
			n + 38	22	0	0
			n + 39	51	0	0
			n + 40	80	0	0
			n + 42	18	0	0
			n + 43	47	0	0
			n + 44	76	0	0
			n + 46	14	0	0
			n + 47	43	0	0
			n + 48	72	0	0
			n + 50	10	0	0
			n + 51	39	0	0
			n + 52	68	0	0
			n + 54	6	0	0
			n + 55	35	0	0
			n + 56	64	0	0
			n + 58	2	0	0
			n + 59	31	0	0

* 'n' is defined as the RIM count when the MOD 91 count = 0. This is an asynchronous process so that RIM number can not be predetermined.

Table 7. Spacecraft Clock (SCLK) Progression (cont'd)

Telemetry Rate (kb/s)	Rate Real-Time	Record	RIM (Modulo 120)	MOD91	MOD10	MOD8
0.010	Yes	No	n + 60	60	0	0
(cont)			n + 61	89	0	0
			n + 63	27	0	0
			n + 64	56	0	0
			n + 65	85	0	0
			n + 67	23	0	0
			n + 68	52	0	0
			n + 69	81	0	0
			n + 71	19	0	0
			n + 72	48	0	0
			n + 73	77	0	0
			n + 75	15	0	0
			n + 76	44	0	0
			n + 77	73	0	0
			n + 79	11	0	0
			n + 80	40	0	0
			n + 81	69	0	0
			n + 83	7	0	0
			n + 84	36	0	0
			n + 85	65	0	0
			n + 87	3	0	0
			n + 88	32	0	0
			n + 89	61	0	0
			n + 90	90	0	0
			n + 92	28	0	0
			n + 93	57	0	0
			n + 94	86	0	0
			n + 96	24	0	0
			n + 97	53	0	0
			n + 98	82	0	0
			n + 100	20	0	0
			n + 101	49	0	0
			n + 102	78	0	0
			n + 104	16	0	0
			n + 105	45	0	0
			n + 106	74	0	0
			n + 108	12	0	0
			n + 109	41	0	0
			n + 110	70	0	0
			n + 112	8	0	0
			n + 113	37	0	0
			n + 114	66	0	0
			n + 116	4	0	0
			n + 117	33	0	0
			n + 118	62	0	0
			n + 120	0	0	0

3.9.2.3.5 <u>Spacecraft Clock Progression.</u> The SCLK shall increment as shown in Table 7 for each of the various telemetry rates, except the KPR mode at 40 b/s and the LMF mode at 600 b/s. The KPR mode consists exclusively of alternate 1-0 data, i. e., no header; therefore, the SCLK progression of Table 7 does not apply to this mode. See 3.9.21 for additional detail. The LMF mode consists exclusively of indeterminate data, i.e., no header; therefore, the SCLK progression of Table 7 does not apply to this mode. See 3.9.22 for additional detail. The 10 b/s coded telemetry shall be enforced two MFs after the receipt of telemetry mode change command. The first engineering frame at 10 b/s will be whatever position is current within the RIM and afterward every 120th engineering frame shall be downlinked.

3.9.3 <u>ENG - Engineering</u>

The ENG frame shall be the carrier of S/C engineering data. The schematic of the ENG frame is shown in Figure 6 and described in greater detail in Table 8.

HEADER	ENGINEERING DATA
96	704

Figure 6. ENG Frame

Table 8. ENG Format

Data Description	Bits Frame	Bits sec 10	40	1200	Offset to Start of Data	Paragraph
Header	96	1.2	4.8	144	0	3.9.2
Engineering	704	8.8	35.2	1056	96	A2.2
	800	10	40	1200		
Frame Time (seconds) =		80	20	0.666 2/3		

3.9.3.1 <u>Source.</u> The ENG frame shall exist in the downlink telemetry as a result of:

a. Being transmitted at a real-time rate of 1200 b/s.
b. Being embedded at 1200 b/s in any LRS frame.
c. Being played back from the S/C tape recorder within any LRS frame.
d. Being transmitted at 40 b/s over the S-band downlink concurrently with any other data being transmitted on the X-band link. This 40 b/s S-band mode shall be known as snapshot engineering.
e. Being transmitted at 10 b/s to the high rate channel of MDS.
f. Being transmitted at 40 b/s on X-band.

3.9.3.2 Contents. Each engineering frame shall contain data of the following types:

a. Engineering subsystem analog, digital, and software measurements.
b. Spacecraft system level status measurements.
c. Selected science subsystem temperature measurements.

3.9.3.3 Spacecraft Clock Progression. The SCLK (see paragraph 3.9.2.3) in successive ENG frames shall increment as shown in Table 9. The table is organized by Subcommutation Index (SI) and data rate.

The expressions for computing the engineering SI shall be as shown in Table 9.

3.9.3.4 ENG Frame Characteristics. The 40 b/s ENG frame shall exist in real-time as a result of being collected at 1200 b/s but being transmitted at the 40 b/s rate. This mode shall be known as snapshot engineering. As a result of this mode, every 30th engineering frame created at 1200 b/s shall be downlinked. The data contained within the 40 b/s engineering frame shall represent a snapshot of the engineering data contained within the EHR frame.

The 10 b/s ENG frame shall exist in real-time as a result of being collected at 1200 b/s but being transmitted at the 10 b/s rate. This mode shall be known as engineering low rate snapshot. As a result of this mode, every 120th engineering frame created at 1200 b/s shall be downlinked. The data contained within the 10 b/s engineering frame shall represent a snapshot of the engineering data contained within the EHR frame.

Table 9. Subcommutation Index (SI) Progression

1200 b/s or 40 b/s or 10 b/s snapshot of 1200 b/s*

SI	RIM	MOD91	MOD10	MOD8
0	i	0	0	0
1	i	1	0	0
2	i	2	0	0
.	.	.	0	0
.	.	.	0	0
.	.	.	0	0
90	i	90	0	0

SI = MOD91

* The SI expression and following table are valid for all telemetry modes (see Table 1)

3.9.4 LRS - Low-Rate Science

The LRS frame shall be the primary carrier of the low-rate fields and particles data and engineering data at 1200 b/s. The schematic of the LRS frame is shown in Figure 7 and described in greater detail in Table 10.

|-------------------------------- GOLAY CODED AREA --------------------------------|

HEADER	ENGI-NEER-ING	UVS	HIC / EUV	SSI STATUS	PLS	NIMS STATUS		DDS	CODED RESERVE	EPD		EPD	PPR	MAG		MAG	PWS	AACS	
96	704	672	96	96	408	24		16	16	400		208	144	80		80	160	192	

GOLAY PARITY SYMBOLS (432 EACH) — GOLAY PARITY SYMBOLS (432 EACH)

Figure 7. LRS Frame

3.9.4.1 Source. The LRS frame shall exist in the downlink telemetry as a result of:

a. Being transmitted at a real-time rate of 7.68 kb/s as either real-time data or playback data.

b. Being multiplexed in 512 bit groups (1/10 LRS) into all real-time transmissions exceeding 7.68 kb/s.

c. Being embedded in S/C tape recorder playback frames when the data was recorded at 7.68 kb/s.

d. Being multiplexed in 512 or 64 (1/80 LRS) bit segments into all frames recorded on the S/C tape recorder at rates exceeding 7.68 kb/s when these frames are being played back.

Table 10. LRS Format

Data Description	Bits / Frame	Bits / Sec	Offset to Start of Data: W/Golay	Offset to Start of Data: W/O Golay (After Removal by Ground)	Paragraph
Header	96	144	0	0	3.9.2
Engineering Data	704	1056	96	96	A2.2
UVS	672	1008	800	800	A2.13
HIC/EUV	96	144	1472	1472	A2.6A/A2.6B
SSI Status	96	144	1568	1568	A2.12
PLS	408	612	1664	1664	A2.9
NIMS Status	24	36	2072	2072	A2.8
Golay Parity	432	648	2096		
DDS	16	24	2528	2096	A2.5
Coded Reserve	16	24	2544	2112	
EPD (Part 1)	400	912	2560	2128	A2.6
Golay Parity	432	648	2960		
EPD (Part 2)	208	- -	3392	2528	
PPR	144	216	3600	2736	A2.10
MAG (Part 1)	80	240	3744	2880	A2.7
Golay Parity	432	648	3824		
MAG (Part 2)	80	- -	4256	2960	
PWS	160	240	4336	3040	A2.11
AACS Position and Rate Data	192	288	4496	3200	A2.4
Golay Parity	432	648	4688		
	5120	7680	(W/Golay)		
	3392	5088	(W/O Golay)		

Frame Time = 0.666 2/3 second

3.9.4.2 Spacecraft Clock Progression. The SCLK (see paragraph 3.9.2.3) in successive LRS frames shall increment as shown below.

LRS Minor Frame	RIM	MOD 91	MOD10	MOD8
0	i	0	0	0
1	i	1	0	0
2	i	2	0	0
3	i	3	0	0
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
89	i	89	0	0
90	i	90	0	0
0	i+i	0	0	0
1	i+1	1	0	0
2	i+i	2	0	0
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.

Minor frame = MOD91

3.9.5 MPW - Medium-Rate Science, PWS Data

The MPW frame shall be used for acquiring NIMS and PWS data for real-time transmission and recording the data on the S/C tape recorder. The schematic of the MPW frame is shown in Figure 8 and described in greater detail in Table 11.

HEADER	1/10 LRS	NIMS	PWS	FILLER
96	512	768	512	32

Figure 8. MPW Frame

Table 11. MPW Format

Data Description	Bits Frame	Bits Sec	Offset to Data Start	Paragraph
Header	96	1440	0	3.9.2
1/10 Low-Rate Science	512	7680	96	3.9.4
NIMS	768	11520	608	A2.8
Medium Rate PWS	512	7680	1376	A2.11
Filler	32	480	1888	
	1920	28800		
Frame Time = 0.066 2/3 second				

3.9.5.1 Source. The MPW frame shall exist in the downlink telemetry either in real-time or as a result of S/C tape recorder playback.

3.9.5.2 Spacecraft Clock Progression. The SCLK (see paragraph 3.9.2.3) in successive frames shall increment as shown below:

RIM	MOD 91	MOD10	MOD8
i (i=any)	0	0	0
i	0	1	0
.	.	.	.
.	.	.	.
.	.	.	.
i	0	9	0
i	1	0	0
i	1	1	0
i	.	.	.
i	.	.	.
i	.	.	.
i	90	8	0
i	90	9	0
i+i	0	0	0
.	.	.	.
.	.	.	.
.	.	.	.

3.9.5.3 <u>Embedded Frame Build Up.</u> This frame contains embedded LRS data. This data shall be built into a structure identical to its real-time equivalent.

The CDS shall embed 1/10 of a LRS frame (512 bits) into each of these frames. There shall be a delay of one LRS frame time between the collection and embedding of the LRS data. As a result of this delay, the relationship between the SCLK in the frame and the SCLK in the embedded LRS frame shall be as shown below:

Frame Containing 1/10 LRS Frame				Embedded LRS Frame			
RIM	MOD 91	MOD10	MOD8	RIM	MOD 91	MOD10	MOD8
i	0	0	0	i-1	90	0	0
i	1	0	0	i	0	0	0
i	2	0	0	i	1	0	0
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
i	90	0	0	i	89	0	0

The expressions for computing the embedded LRS minor frame and segment number within the frame are:

$$S = \text{Remainder of } \left[\frac{900 + 10*\text{MOD 91} + \text{MOD10}}{910} \right]$$

LRS Minor Frame = Integer portion [S/10]

LRS Segment Number = Remainder of [S/10]

3.9.5A **MPP - Medium-Rate Science, PWS Data without NIMS**

The MPP frame shall be used for acquiring PWS data for real time transmission and recording the data on the S/C tape recorder. The schematic of the MPP frame is shown in Figure 8A and described in greater detail in Table 11A.

HEADER	1/10 LRS	PWS	FILLER
96	512	1280	32

Figure 8A. MPP Frame

Table 11A. MPP Format

Data Description	Bits/Frame	Bits/Sec	Offset to Data Start	Paragraph
Header	96	1440	0	3.9.2
1/10 Low-Rate Science	512	7680	96	3.9.4
Medium Rate PWS	1280	19200	608	Various
Filler	32	480	1888	
	1920	28800		
Frame Time = 0.066 2/3 second				

3.9.5A.1 Source. The MPP frame shall exist in the downlink telemetry either in real-time or as a result of S/C tape recorder playback.

3.9.5A.2 Spacecraft Clock Progression. The SCLK (see paragraph 3.9.2.3) in successive frames shall increment as described in paragraph 3.9.5.2.

3.9.5A.3 Embedded Frame Build Up. This frame contains embedded LRS data. This data shall be built into a structure identical to its real-time equivalent as described in paragraph 3.9.5.3.

3.9.6 MPB - Medium-Rate Playback

The MPB frame shall be used to carry S/C tape recorder playback data to the ground. The schematic of the MPB frame is shown in Figure 9 and described in greater detail in Table 12.

HEADER	1/10 LRS	PLAYBACK	FILLER
96	512	1280	32

Figure 9. MPB Frame

Table 12. MPB Format

Data Description	Bits Frame	Bits Sec	Offset to Data Start	Paragraph
Header	96	1440	0	3.9.2
1/10 Low-Rate Science	512	7680	96	3.9.4
Playback Data	1280	19200	608	Various
Filler	32	480	1888	
	1920	28800		
Frame Time = 0.066 2/3 second				

3.9.6.1 Source. The MPB frame shall exist in the downlink telemetry exclusively in real-time.

3.9.6.2 Spacecraft Clock Progression. The SCLK (see paragraph 3.9.2.3) in successive frames shall increment as described in paragraph 3.9.5.2.

3.9.6.3 Embedded Frame Build Up. The MPB frame contains embedded LRS data. This data shall be built into a structure identical to its real-time equivalent as described in paragraph 3.9.5.3.

3.9.7 XED - Intermediate-Rate Science, Compressed and Edited Imaging

The XED frame shall be used for acquiring NIMS and SSI data for real-time transmission. The schematic of the XED frame is shown in Figure 10 and described in greater detail in Table 13.

HEADER	1/10 LRS	NIMS	COMPRESSED AND EDITED IMAGING	REED SOLOMON PARITY SYMBOLS
96	512	768	2592	512

Figure 10. XED Frame

Table 13. XED Format

Data Description	Bits Frame	Bits Sec	Offset to Data Start	Paragraph
Header	96	1440	0	3.9.2
1/10 Low-Rate Science	512	7680	96	3.9.4
NIMS	768	11520	608	A2.8
Compressed and Edited Imaging	2592	38880	1376	A2.12
Reed Solomon Parity Symbols	512	7680		
	4480	67200		
Frame Time = 0.066 2/3 second				

3.9.7.1 Source. The XED frame shall exist in the downlink telemetry exclusively in real-time.

3.9.7.2 Spacecraft Clock Progression. The SCLK (see paragraph 3.9.2.3) in successive frames shall increment as described in paragraph 3.9.5.2.

3.9.7.3 Embedded Frame Build Up. The XED frame contains embedded LRS data. This data shall be built into a structure identical to its real-time equivalent as described in paragraph 3.9.5.3.

3.9.8 XCM - Intermediate-Rate Science, Compressed Imaging

The XCM frame shall be used for acquiring NIMS and SSI data for real-time transmission. The schematic of the XCM frame is shown in Figure 11 and described in greater detail in Table 14.

HEADER	1/10 LRS	NIMS	COMPRESSED IMAGING	REED SOLOMON PARITY SYMBOLS
96	512	768	2592	512

Figure 11. XCM Frame

Table 14. XCM Format

Data Description	Bits Frame	Bits Sec	Offset to Data Start	Paragraph
Header	96	1440	0	3.9.2
1/10 Low-Rate Science	512	7680	96	3.9.4
NIMS	768	11520	608	A2.8
Compressed Imaging	2592	38880	1376	A2.12
Reed Solomon Parity Symbols	512	7680		
	4480	67200		
Frame Time = 0.066 2/3 second				

3.9.8.1 Source. The XCM frame shall exist in the downlink telemetry exclusively in real-time.

3.9.8.2 Spacecraft Clock Progression. The SCLK (see paragraph 3.9.2.3) in successive frames shall increment as described in paragraph 3.9.5.2.

3.9.8.3 Embedded Frame Build Up. The XCM frame contains embedded LRS data. This data shall be built into a structure identical to its real-time equivalent as described in paragraph 3.9.5.3.

3.9.9 XPW - Intermediate-Rate Science, PWS

The XPW frame shall be used for acquiring NIMS and PWS data for real-time transmission. The schematic of the XPW frame is shown in Figure 12 and described in greater detail in Table 15.

HEADER	1/10 LRS	NIMS	PWS
96	512	768	3104

Figure 12. XPW Frame

Table 15. XPW Format

Data Description	Bits Frame	Bits Sec	Offset to Data Start	Paragraph
Header	96	1440	0	3.9.2
1/10 Low-Rate Science	512	7680	96	3.9.4
NIMS	768	11520	608	A2.8
PWS	3104	46560	1376	A2.11
	4480	67200		
Frame Time = 0.066 2/3 second				

3.9.9.1 Source. The XPW frame shall exist in the downlink telemetry exclusively in real-time.

3.9.9.2 Spacecraft Clock Progression. The SCLK (see paragraph 3.9.2.3) in successive frames shall increment as described in paragraph 3.9.5.2.

3.9.9.3 Embedded Frame Build Up. The XPW frame contains embedded LRS data. This data shall be built into a structure identical to its real-time equivalent as described in paragraph 3.9.5.3.

3.9.10 XPB - Intermediate Playback

The XPB frame shall be used to carry S/C tape recorder PB data to the ground. The schematic of the XPB frame is shown in Figure 13 and described in greater detail in Table 16.

HEADER	1/10 LRS	PLAYBACK	FILLER
96	512	3840	32

Figure 13. XPB Frame

Table 16. XPB Format

Data Description	Bits Frame	Bits Sec	Offset to Data Start	Paragraph
Header	96	1440	0	3.9.2
1/10 Low Rate Science	512	7680	96	3.9.4
Playback Data	3840	57600	608	Various
Filler	32	480	4448	
	4480	67200		
Frame Time = 0.066 2/3 second				

3.9.10.1 Source. The XPB frame shall exist in the downlink telemetry exclusively in real-time.

3.9.10.2 Spacecraft Clock Progression. The SCLK (see paragraph 3.9.2.3) in successive frames shall increment as described in paragraph 3.9.5.2.

3.9.10.3 Embedded Frame Build Up. The XPB contains embedded LRS data. This data shall be built into a structure identical to its real-time equivalent as described in paragraph 3.2.5.3.

3.9.10A XRW - Intermediate-Rate Real Time PWS at 80.64 kbps.

The XRW frame shall be used for acquiring NIMS and PWS data for real-time transmission at 80.64 kbps. The schematic of the XRW frame is shown in Figure 13A and described in greater detail in Table 16A.

HEADER	1/10 LRS	NIMS	PWS	FILLER
96	512	768	3104	896

Figure 13A. XRW Frame

Table 16A. XRW Format

Data Description	Bits Frame	Bits Sec	Offset to Data Start	Paragraph
Header	96	1440	0	3.9.2
1/10 Low-Rate Science	512	7680	96	3.9.4
NIMS	768	11520	608	A2.8
PWS	3104	46560	1376	A2.11
Filler	896	13440	4480	--
	5376	80640		
Frame Time = 0.066 2/3 second				

3.9.10A.1 Source. The XRW frame shall exist in the downlink telemetry exclusively in real-time.

3.9.10A.2 Spacecraft Clock Progression. The SCLK (see paragraph 3.9.2.3) in successive frames shall increment as described in paragraph 3.9.5.2.

3.9.10A.3 Embedded Frame Build Up. The XRW frame contains embedded LRS data. This data shall be built into a structure identical to its real-time equivalent as described in paragraph 3.9.5.3.

3.9.10B <u>XPN - Intermediate-Rate Playback with NIMS at 80.64 kbps.</u>

The XPN frame shall be used to carry S/C tape recorder PB data to the ground with LRS and NIMS data in real-time. The schematic of the XPN frame is shown in Figure 13B and described in greater detail in Table 16B.

HEADER	1/10 LRS	NIMS	PLAYBACK	FILLER
96	512	768	3840	160

Figure 13B. XPN Frame

Table 16B. XPN Format

Data Description	Bits Frame	Bits Sec	Offset to Data Start	Paragraph
Header	96	1440	0	3.9.2
1/10 Low-Rate Science	512	7680	96	3.9.4
NIMS	768	11520	608	A2.8
Playback	3840	57600	1376	Various
Filler	160	2400	5216	--
	5376	80640		
Frame Time = 0.066 2/3 second				

3.9.10B.1 <u>Source.</u> The XPN frame shall exist in the downlink telemetry exclusively in real-time.

3.9.10B.2 <u>Spacecraft Clock Progression.</u> The SCLK (see paragraph 3.9.2.3) in successive frames shall increment as described in paragraph 3.9.5.2.

3.9.10B.3 <u>Embedded Frame Build Up.</u> The XPN frame contains embedded LRS data. This data shall be built into a structure identical to its real-time equivalent as described in paragraph 3.9.5.3.

3.9.11 HIM - High-Rate Science, Imaging

The HIM frame shall be used for acquiring NIMS and Imaging data for real-time transmission and/or recording on the S/C tape recorder. The schematic of the HIM frame is shown in Figure 14 and described in greater detail in Table 17.

HEADER	1/10 LRS	NIMS	IMAGING
96	512	768	6304

Figure 14. HIM Frame

Table 17. HIM Format

Data Description	Bits Frame	Bits Sec	Offset to Data Start	Paragraph
Header	96	1440	0	3.9.2
1/10 Low-Rate Science	512	7680	96	3.9.4
NIMS	768	11520	608	A2.8
Imaging	6304	94560	11376	A2.12
	7680	115200		
Frame Time = 0.066 2/3 second				

3.9.11.1 Source. The HIM format shall exist in the downlink telemetry either in real-time or as a result of S/C tape recorder playback.

3.9.11.2 Spacecraft Clock Progression. The SCLK (see paragraph 3.9.2.3) in successive frames shall increment as described in paragraph 3.9.5.2.

3.9.11.3 Embedded Frame Build Up. The HIM frame contains embedded LRS data. This data shall be built into a structure identical to its real-time equivalent as described in paragraph 3.9.5.3.

3.9.12 HCM - High-Rate Science, Compressed Imaging

The HCM frame shall be used for acquiring NIMS and Imaging for real-time transmission. The schematic of the HCM frame is shown in Figure 15 and described in greater detail in Table 18.

HEADER	1/10 LRS	NIMS	COMPRESSED IMAGING	REED SOLOMON PARITY SYMBOLS	COMPRESSED IMAGING	REED SOLOMON PARITY SYMBOLS	FILLER
96	512	768	2592	512	2592	512	96

Figure 15. HCM Frame

Table 18. HCM Format

Data Description	Bits Frame	Bits Sec	Offset to Data Start	Paragraph
Header	96	1440	0	3.9.2
1/10 Low-Rate Science	512	7680	96	3.9.4
NIMS	768	11520	608	A2.8
Compressed Imaging	2592	38880	1376	A2.12
Reed Solomon Parity Symbols	512	7680	3968	A2.12
Compressed Imaging	2592	38880	4480	A2.12
Reed Solomon Parity Symbols	512	7680	7072	A2.12
Filler	96	1440	7584	
	7680	115200		
Frame Time = 0.066 2/3 second				

3.9.12.1 Source. The HCM frame shall exist in the downlink telemetry exclusively in real-time.

3.9.12.2 Spacecraft Clock Progression. The SCLK (see paragraph 3.9.2.3) in successive frames shall increment as shown below:

RIM	MOD91	MOD10	MOD8	Picture	Line
i	0	0	0	0	0,1
i	0	1	0	0	2,3
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
i	0	9	0	0	18,19
i	1	0	0	0	20,21
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
i	45	4	0	0	908,909
i	45	5	.	1	0,1
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
i	90	9	0	1	908,909

The expressions corresponding to this table are:

$$S = 2*((10*MOD91) + MOD10)$$

$$PICTURE = \text{Integer of } [S/910]$$

$$LINE_{LEFT} = \text{Remainder of } [S/910]$$

$$LINE_{RIGHT} = [\text{Remainder of } [S/910] +1$$

3.9.12.3 Embedded Frame Build Up. The HCM frame contains embedded LRS data. This data shall be built into a structure identical to its real-time equivalent as described in paragraph 3.9.5.3.

3.9.12A HCJ - High-Rate Science, Compressed Imaging and PWS

The HCJ frame shall be used for acquiring NIMS, PWS and Imaging for real-time transmission. The schematic of the HCJ frame is shown in Figure 15A and described in greater detail in Table 18A.

HEADER	1/10 LRS	NIMS	COMPRESSED IMAGING	REED SOLOMON PARITY SYMBOLS	COMPRESSED IMAGING	REED SOLOMON PARITY SYMBOLS	FILLER	PWS
96	512	768	2592	512	2592	512	512	864

Figure 15A. HCJ Frame

Table 18A. HCJ Format

Data Description	Bits Frame	Bits Sec	Offset to Data Start	Paragraph
Header	96	1440	0	3.9.2
1/10 Low-Rate Science	512	7680	96	3.9.4
NIMS	768	11520	608	A2.8
Compressed Imaging	2592	38880	1376	A2.12
Reed Solomon Parity Symbols	512	7680	3968	A2.12
Compressed Imaging	2592	38880	4480	A2.12
Reed Solomon Parity Symbols	512	7680	7072	A2.12
Filler	512	7680	7584	----
PWS	864	12960	8096	
	8960	134400		
Frame Time = 0.066 2/3 second				

3.9.12A.1 Source. The HCJ frame shall exist in the downlink telemetry exclusively in real-time.

3.9.12A.2 Spacecraft Clock Progression. The SCLK (see paragraph 3.9.2.3) in successive frames shall increment as described in paragraph 3.9.5.2.

3.9.12A.3 Embedded Frame Build Up. The HCJ frame contains embedded LRS data. This data shall be built into a structure identical to its real-time

3.9.13 HPW - High-Rate Science, PWS. The HPW frame shall be used for acquiring NIMS and PWS data for real-time transmission and/or recording on the S/C tape recorder. The schematic of the HPW frame is shown in Figure 16 and described in greater detail in Table 19.

HEADER	1/10 LRS	NIMS	PWS
96	512	768	6304

Figure 16. HPW Frame

Table 19. HPW Format

Data Description	Bits Frame	Bits Sec	Offset to Data Start	Paragraph
Header	96	1440	0	3.9.2
1/10 Low-Rate Science	512	7680	96	3.9.4
NIMS	768	11520	608	A2.8
PWS	6304	94560	1376	A2.11
	7680	115200		
Frame Time = 0.066 2/3 second				

3.9.13.1 Source. The HPW frame shall exist in the downlink telemetry either in real-time or as a result of S/C tape recorder playback.

3.9.13.2 Spacecraft Clock Progression. The SCLK (see paragraph 3.9.2.3) in successive frames shall increment as described in paragraph 3.9.5.2.

3.9.13.3 Embedded Frame Build Up. The HPW frame contains embedded LRS data. This data shall be built into a structure identical to its real-time equivalent as described in paragraph 3.9.5.3.

3.9.14 HPB - High-Rate Playback

The HPB frame shall be used to carry S/C recorder playback data to the ground. The schematic of the HPB frame is shown in Figure 17 and described in greater detail in Table 20.

HEADER	1/10 LRS	PLAYBACK	FILLER
96	512	6720	352

Figure 17. HPB Frame

Table 20. HPB Format

Data Description	Bits Frame	Bits Sec	Offset to Data Start	Paragraph
Header	96	1440	0	3.9.2
1/10 Low-Rate Science	512	7680	96	3.9.4
Playback Data	6720	100800	608	Various
Filler Data	452	5280	7328	
	7680	115200		
Frame Time = 0.066 2/3 second				

3.9.14.1 Source. The HPB frame shall exist in the downlink telemetry exclusively in real-time.

3.9.14.2 Spacecraft Clock Progression. The SCLK (see paragraph 3.9.2.3) in successive frames shall increment as described in paragraph 3.9.5.2.

3.9.14.3 Embedded Frame Build Up. The HPB frame contains embedded LRS data. This data shall be built into a structure identical to its real-time equivalent as described in paragraph 3.9.5.3.

3.9.14A **HRW - High-Rate Real Time PWS at 134.4 kbps.**

The HRW frame shall be used to carry LRS, NIMS and PWS data to the ground at the high data rate of 134.4 kbps in real time. The schematic of the HRW frame is shown in Figure 17A and described in greater detail in Table 20A.

HEADER	1/10 LRS	NIMS	PWS	FILLER
96	512	768	6304	1280

Figure 17A. HRW Frame

Table 20A. HRW Format

Data Description	Bits Frame	Bits Sec	Offset to Data Start	Paragraph
Header	96	1440	0	3.9.2
1/10 Low-Rate Science	512	7680	96	3.9.4
NIMS	768	11520	608	A2.8
PWS	6304	94560	1376	A2.11
Filler	1280	19200	8096	
	8960	134400		
Frame Time = 0.066 2/3 second				

3.9.14A.1 Source. The HRW frame shall exist in the downlink telemetry exclusively in real time.

3.9.14A.2 Spacecraft Clock Progression. The SCLK (see paragraph 3.9.2.3) in successive frames shall increment as described in paragraph 3.9.5.2.

3.9.14A.3 Embedded Frame Build Up. The HRW frame contains embedded LRS data. This data shall be built into a structure identical to its real-time equivalent as described in paragraph 3.9.5.3.

3.9.14B <u>HPJ - High-Rate Playback with NIMS and PWS at 134.4 kbps.</u>

The HPJ frame shall be used to carry S/C recorder playback data to the ground with LRS, NIMS, and PWS data in real time. The schematic of the HPJ frame is shown in Figure 17B and described in greater detail in Table 20B.

HEADER	1/10 LRS	NIMS	PLAYBACK	PWS
96	512	768	6720	864

Figure 17B. HPJ Frame

Table 20B. HPJ Format

Data Description	Bits Frame	Bits Sec	Offset to Data Start	Paragraph
Header	96	1440	0	3.9.2
1/10 Low-Rate Science	512	7680	96	3.9.4
NIMS	768	11520	608	A2.8
Playback	6720	100800	1376	Various
PWS	864	12960	8096	A2.11
	8960	134400		
Frame Time = 0.066 2/3 second				

3.9.14B.1 <u>Source.</u> The HPJ frame shall exist in the downlink telemetry exclusively in real time.

3.9.14B.2 <u>Spacecraft Clock Progression.</u> The SCLK (see paragraph 3.9.2.3) in successive frames shall increment as described in paragraph 3.9.5.2.

3.9.14B.3 <u>Embedded Frame Build Up.</u> The HPJ frame contains embedded LRS data. This data shall be built into a structure identical to its real-time equivalent as described in paragraph 3.9.5.3.

3.9.15 IM8 - Imaging Recorded at 806.4 kb/s

The IM8 frame shall be used to record SSI data at 806.4 kb/s. The schematic of the IM8 frame is shown in Figure 18 and described in greater detail in Table 21.

HEADER	1/80 LRS	1/8 NIMS	FILLER	IMAGING
96	64	96	64	6400

Figure 18. IM8 Frame

Table 21. IM8 Format

Data Description	Bits Frame	Bits Sec	Offset to Data Start	Paragraph
Header	96	11520	0	3.9.2
1/80 Low-Rate Science	64	7680	96	3.9.4
1/8 NIMS	96	11520	160	A2.8
Filler Data	64	7680	256	
Imaging	6400	768000	320	A2.12
	6720	806400		
Frame Time = 0.008 1/3 second				

3.9.15.1 Source. The IM8 frame shall exist in the downlink telemetry exclusively as a result of S/C tape recorder playback.

3.9.15.2 Spacecraft Clock Progression. The SCLK (see paragraph 3.9.2.3) in successive frames shall increment as shown in Table 22.

Table 22. IM8 Spacecraft Clock Progression

RIM	MOD91	MOD10	MOD8	Picture	Line
i	0	0	0,1,2, ..., 7	0	0,1,2, ..., 7
i	0	1	0,1,2, ..., 7	0	8.9,10, ..., 15
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
i	0	9	0,1,2, ..., 7	0	72,73,74, ..., 79
i	1	0	0,1,2, ..., 7	0	80,81,82, ..., 87
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
i	12	9	0,1,2, ..., 7	0	1032,1033, ..., 1039
i	13	0	0,1,2, ..., 7	1	0,1,2, ..., 7
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
i	90	9	0,1,2, ..., 7	6	1032,1033, ..., 1039

The expressions corresponding to Table 22 are

S = 8(10*MOD91 + MOD10) + MOD8
PICTURE = Integer Portion of [S/1040]
LINE = Remainder of [S/1040]

3.9.15.3 <u>Embedded Frame Build Up.</u> The IM8 frame contains two embedded data types: LRS and NIMS. Each of these data types shall be built into structures identical to their real-time equivalent.

3.9.15.3.1 <u>LRS.</u> Each IM8 frame contains one segment of an LRS frame. Eighty (80) segments are required to create the real-time equivalent LRS frame.

The CDS shall embed 1/80 of a LRS frame (64 bits) into each of these frames. There shall be a delay of one LRS frame-time between the collection and embedding of the LRS data into the frame. As a result of this delay, the relationship of the SCLK in the frame and the SCLK in the embedded LRS frame shall be as shown below.

Frame Containing 1/80 LRS Frame				Embedded LRS Frame			
RIM	MOD91	MOD10	MOD8	RIM	MOD91	MOD10	MOD8
i	0	1	0	i-1	90	0	0
i	1	1	0	i	0	0	0
i	2	1	0	i	1	0	0
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
i	90	1	0	i	89	0	0

The expressions for computing the LRS minor frame and segment number with the minor frames are:

$$S = \text{Remainder of } \frac{7194 + 8(10*MOD91 + MOD10) + MOD8}{7280}$$

LRS Minor Frame = Integer [S/80]

LRS Segment Number = Remainder of [S/80]

3.9.15.3.2 NIMS. Each frame contains one segment (96 bits) of a NIMS real-time packet. Eight (8) segments are required to create the real-time equivalent NIMS frame.

The S/C clock of the frame which contains the first of 8 segments of the embedded NIMS frame is shown below.

Frame Containing 1/8 NIMS Frame				Embedded NIMS Frame			
RIM	MOD91	MOD10	MOD8	RIM	MOD91	MOD10	MOD8
i	0	0	0	i-1	90	0	0
i	0	1	0	i	0	0	0
i	0	2	0	i	0	1	0
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
i	0	9	0	i	0	8	0
i	1	0	0	i	0	9	0
i	1	1	0	i	1	0	0
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
i	90	9	0	i	90	8	0

The expressions for computing the NIMS data packet and segment number within the packet are:

$$S = \text{Remainder of } \frac{7272 + 8(10*MOD91 + MOD10) + MOD8}{7280}$$

NIMS Minor Frame = Integer Portion of [S/8]

NIMS Segment Number = Remainder of [S/8]

3.9.15A AI8 - Imaging Recorded at 806.4 kb/s

The AI8 frame shall be used to record averaged SSI data at 806.4 kb/s. The schematic of the AI8 frame is shown in Figure 18A and described in greater detail in Table 22A.

HEADER	1/80 LRS	1/8 NIMS	FILLER	IMAGING	IMAGING
96	64	96	64	3200	3200

Figure 18A. AI8 Frame

Table 22A. AI8 Format

Data Description	Bits Frame	Bits Sec	Offset to Data Start	Paragraph
Header	96	11520	0	3.9.2
1/80 Low-Rate Science	64	7680	96	3.9.4
1/8 NIMS	96	11520	160	A2.8
Filler Data	64	7680	256	
Imaging	3200	384000	320	A2.12
Imaging	3200	384000	3520	A2.12
	6720	806400		
Frame Time = 0.008 1/3 second				

3.9.15A.1 Source. The AI8 frame shall exist in the downlink telemetry exclusively as a result of S/C tape recorder playback.

3.9.15A.2 Spacecraft Clock Progression. The SCLK (see paragraph 3.9.2.3) in successive frames shall increment as shown in Table 22B.

Table 22B. AI8 Spacecraft Clock Progression

RIM	MOD91	MOD10	MOD8	Picture	Line
i	0	0	0,1,2, ..., 7	0	0,1,2, ..., 15
i	0	1	0,1,2, ..., 7	0	16,17,18,...,31
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
i	0	9	0,1,2, ..., 7	0	144,145,146,...,159
i	1	0	0,1,2, ..., 7	0	160,161,162,...,175
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
i	3	9	0,1,2, ..., 7	0	624,625,626,...,639
i	4	0	0,1,2, ..., 7	1	0,1,2, ...,15
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
i	6	9	0,1,2, ..., 7	1	464,465,466,...,479
i	7	0	0,1,2, ..., 7	2	0,1,2, ...,15
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
i	90	9	0,1,2, ..., 7	26	464,465,466,...,479

3.9.15A.3 Embedded Frame Build Up. The AI8 frame contains two embedded data types: LRS and NIMS. Each of these data types shall be built into structures identical to their real-time equivalent.

3.9.15A.3.1 LRS. The embedded LRS data is as described in paragraph 3.9.15.3.1.

3.9.15A.3.2 NIMS. The embedded NIMS data is as described in paragraph 3.9.15.3.2.

3.9.16 PW8 - PWS Recorded at 806.4 kb/s

The PW8 frame shall be used to record PWS data at 806.4 kb/s. The schematic of the PW8 frame is shown in Figure 19 and described in greater detail in Table 23.

HEADER	1/80 LRS	1/8 NIMS	FILLER	PWS
96	64	96	64	6400

Figure 19. PW8 Frame

Table 23. PW8 Format

Data Description	Bits Frame	Bits Sec	Offset to Data Start	Paragraph
Header	96	11520	0	3.9.2
1/80 Low-Rate Science	64	7680	96	3.9.4
1/8 NIMS	96	11520	160	A2.8
Filler Data	64	7680	256	
PWS	6400	768000	320	A2.11
	6720	806400		
Frame Time = 0.008 1/3 second				

3.9.16.1 Source. The PW8 frame shall exist in the downlink telemetry exclusively as a result of S/C tape recorder playback.

3.9.16.2 Spacecraft Clock Progression. The SCLK (see paragraph 3.9.2.3) in successive frames shall increment as described in paragraph 3.9.15.2.

3.9.16.3 Embedded Frame Build Up. The PW8 frame contains two embedded data types: LRS and NIMS. Each of these data types shall be built into structures identical to their real-time equivalent.

3.9.16.3.1 LRS. Each PW8 frame contains one segment of an LRS frame. Eighty (80) segments are required to create the real-time equivalent LRS frame as described in paragraph 3.9.15.3.1.

3.9.16.3.2 NIMS. Each PW8 frame contains one segment of a NIMS real-time frame. Eight (8) segments are required to create the real-time equivalent NIMS frame as described in paragraph 3.9.15.3.2.

3.9.17 <u>IM4 - Compressed Imaging Recorded at 403.2 kb/s</u>

The IM4 frame shall be used to record SSI data at 403.2 kb/s. The schematic of the IM4 frame is shown in Figure 20 and described in greater detail in Table 24.

HEADER	1/80 LRS	1/8 NIMS	COMPRESSED IMAGING	REED SOLOMON PARITY SYMBOLS
96	64	96	2592	512

Figure 20. IM4 Frame

Table 24. IM4 Format

Data Description	Bits Frame	Bits Sec	Offset to Data Start	Paragraph
Header	96	11520	0	3.9.2
1/80 Low-Rate Science	64	7680	96	3.9.4
1/8 NIMS	96	11520	160	A2.8
Compressed Imaging	2592	311040	256	A2.12
Reed Solomon Parity Symbols	512	61440	2848	
	3360	403200		
Frame Time = 0.008 1/3 second				

3.9.17.1 <u>Source.</u> The IM4 frame shall exist in the downlink telemetry exclusively as a result of S/C tape recorder playback.

3.9.17.2 <u>Spacecraft Clock Progression.</u> The SCLK (see paragraph 3.9.2.3) in successive frames shall increment as described in paragraph 3.9.15.2.

3.9.17.3 <u>Embedded Frame Build Up.</u> The IM4 frame contains two embedded data types: LRS and NIMS. Each of these data types shall be built into structures identical to their real-time equivalent.

3.9.17.3.1 <u>LRS.</u> Each IM4 frame contains one segment of an LRS frame. Eighty (80) segments are required to create the real-time equivalent LRS frame as described in paragraph 3.9.15.3.1.

3.9.17.3.2 <u>NIMS.</u> Each IM4 frame contains one segment of a NIMS real-time frame. Eight (8) segments are required to create the real-time equivalent NIMS frame as described in Paragraph 3.9.15.3.2.

3.9.18 PW4 - PWS Recorded at 403.2 kb/s

The PW4 frame shall be used to record PWS data at 403.2 kb/s. The schematic of the PW4 frame is shown in Figure 21 and described in greater detail in Table 25.

HEADER	1/80 LRS	1/8 NIMS	PWS
96	64	96	3104

Figure 21. PW4 Frame

Table 25. PW4 Format

Data Description	Bits Frame	Bits Sec	Offset to Data Start	Paragraph
Header	96	11520	0	3.9.2
1/80 Low-Rate Science	64	7680	96	3.9.4
1/8 NIMS	96	11520	160	A2.8
PWS	3104	372480	256	A2.11
	3360	403200		
Frame Time = 0.008 1/3 second				

3.9.18.1 Source. The PW4 frame shall exist in the downlink telemetry exclusively as a result of S/C tape recorder playback.

3.9.18.2 Spacecraft Clock Progression. The SCLK (see paragraph 3.9.2.3) in successive frames shall increment as described in paragraph 3.9.15.2.

3.9.18.3 Embedded Frame Build Up. The PW4 frame contains two embedded data types: LRS and NIMS. Each of these data types shall be built into structures identical to their real-time equivalent.

3.9.18.3.1 LRS. Each PW4 frame contains one segment of an LRS frame. Eighty (80) segments are required to create the real-time equivalent LRS frame as described in paragraph 3.9.15.3.1.

3.9.18.3.2 NIMS. Each PW4 frame contains one segment of a NIMS real-time frame. Eight (8) segments are required to create the real-time equivalent NIMS frame as described in paragraph 3.9.15.3.2.

3.9.19 BPB - Backup Science, Playback

The BPB frame shall be used to carry S/C tape recorder playback data to the ground. The schematic of the BPB frame is shown in Figure 22 and shown in greater detail in Table 26.

HEADER	1/10 LRS	PLAYBACK
96	512	512

Figure 22. BPB Frame

Table 26. BPB Format

Data Description	Bits Frame	Bits Sec	Offset to Data Start	Paragraph
Header	96	1440	0	3.9.2
1/10 Low-Rate Science	512	7680	96	3.9.4
Playback data	512	7680	608	Various
	1120	16800		
Frame Time = 0.066 2/3 second				

3.9.19.1 Source. The BPB frame shall exist in the downlink telemetry exclusively in real-time.

3.9.19.2 Spacecraft Clock Progression. The SCLK (see paragraph 3.9.2.3) in successive frames shall increment as described in paragraph 3.9.5.2.

3.9.19.3 Embedded Frame Buildup. The BPB frame contains embedded LRS data. This data shall be built into a structure identical to its real-time equivalent as described in paragraph 3.9.5.3.

3.9.20 MPR - Medium-Rate Science, Probe Data.

The MPR frame shall be used for acquiring NIMS and Probe data for real-time transmission and recording the data on the S/C tape recorder. The schematic of the MPR frame is shown in Figure 23 and described in greater detail in Table 27.

HEADER	1/10 LRS	NIMS	PROBE OR GOLAY SYMBOLS*	FILLER
96	512	768	432	112

*Data in even minor frames; parity symbols in odd minor frames

Figure 23. MPR Frame

Table 27. MPR Format

Data Description	Bits Frame	Bits Sec	Offset to Data Start	Paragraph
Header	96	1440	0	3.9.2
1/10 Low-Rate Science	512	7680	96	3.9.4
NIMS	768	11520	608	A2.8
Probe or Golay parity symbols	432	6480	1376	A2.14
Filler Data	112	1680	1808	
	1920	28800		
Frame Time = 0.066 2/3 second				

3.9.20.1 Source. The MPR frame shall exist in the downlink telemetry either in real time or as a result of S/C tape recorder playback.

3.9.20.2 <u>Spacecraft Clock Progression.</u> The SCLK (see paragraph 3.9.2.3) in successive frames shall increment as shown below:

RIM	MOD_91	MOD10	MOD8
i (i=any)	0	0	0
i	0	1	0
.	.	.	.
.	.	.	.
.	.	.	.
i	0	9	0
i	1	0	0
i	1	1	0
.	.	.	.
.	.	.	.
.	.	.	.
i	90	8	0
i	90	9	0
i+1	0	0	0
.	.	.	.
.	.	.	.

3.9.20.3 <u>Embedded Frame Build Up.</u> This frame contains embedded LRS data. This data shall be built into a structure identical to its real time equivalent.

The CDS shall embed 1/10 of a LRS frame (512 bits) into each of these frames. There shall be a delay of one LRS frame time between the collection and embedding of the LRS data. As a result of this delay, the relationship between the SCLK in the frame and the SCLK in the embedded LRS frame shall be as shown below:

Frame Containing 1/10 LRS Frame				Embedded LRS Frame			
RIM	MOD91	MOD10	MOD8	RIM	MOD91	MOD10	MOD8
i	0	0	0	i-1	90	0	0
i	1	0	0	i	0	0	0
i	2	0	0	i	1	0	0
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
i	90	0	0	i	89	0	0

The expressions for computing the embedded LRS minor frame and segment number within the frame are:

$$S = \text{Remainder of } \left[\frac{900 + 10*\text{MOD 91} + \text{MOD10}}{910} \right]$$

LRS Minor Frame = Integer portion [S/10]
LRS Segment Number = Remainder of [S/10]

3.9.20.4 Probe Data Synchronization. The MPR frames alternately contain Probe data and Golay parity symbols. The table below indicates the SCLK value corresponding to either the Probe data or Golay parity symbols.

RIM	MOD91	MOD10	MOD8	Data Type
i	0	0	0	Probe
i	1	0	0	Golay
i	2	0	0	Probe
.	.	.	.	
.	.	.	.	
.	.	.	.	
i	90	0	0	Golay

The expression corresponding to the above table is

$$\text{Remainder of } \left\lfloor \frac{\text{MOD10}}{2} \right\rfloor \quad \begin{matrix} =0 \text{ Probe data} \\ =1 \text{ Golay parity symbols} \end{matrix}$$

3.9.21 KPR - Keep Alive Power On Reset.

The KPR frame shall consist exclusively of alternate 1-0 data at 40 b/s.

3.9.21.1 Source. The KPR frame shall exist in the downlink telemetry as a result of spacecraft failure which has allowed power to the CDS memories to be interrupted. The KPR frame shall be output from the CDS at the high rate channel and low rate channel interfaces to the MDS. The KPR frame can appear in the downlink as uncoded over S-band or (convolutionally) coded over either S-band or X-band, depending on the state of the MDS. Note that the KPR mode will exist in the downlink telemetry whenever the CDS experiences a power on reset (POR), but this existence will be transitory since the CDS will restart telemetry upon recovering from a POR.

3.9.21.2 Spacecraft Clock Progression. Not applicable since the KPR frame does not contain a header. Recovery from a failure which has interrupted CDS memory power requires that the ground re-establish memory contents including the SCLK, reinstate the configuration, and then release the KAPOR lockout of the CDS. This recovery sequence will restart the spacecraft telemetry which has the SCLK incrementing in the normal manner defined in Table 7.

3.9.22 LMF - Launch Memory Failure.

The LMF frame shall consist of an indeterminate data pattern at 600 bps.

3.9.22.1 Source. The LMF frame shall exist in the telemetry through the attached launch vehicle as a result of spacecraft failure which has allowed power to the CDS memories to be interrupted.

3.9.22.2 Spacecraft Clock Progression. Not applicable since the LMF frame does not contain a header.

APPENDIX A

TELEMETRY FRAME FORMAT

COMPONENTS

A1.0 SCOPE

This document establishes the Galileo (GLL) Orbiter requirement for telemetry measurements.

A2.0 TELEMETRY FRAME FORMAT COMPONENTS

A2.1 General

The following paragraphs contain the structure and contents of the elements comprising the various data formats found in GLL-3-280, paragraph 3.9.

A2.2 Engineering Data

The engineering data shall contain a fixed area and a variable area allocation for measurement sampling. The fixed allocation shall be invarient under all the GLL mission phases.

The variable area allocation shall accommodate the various mission phase sampling requirements including anomaly investigations, special tests, spacecraft system test, and performance monitoring. The engineering data shall be allocated as shown in Figure A2.2.1 and described in greater detail in Table A2.2.1.

(100 LEVEL DECK - LESS HEADER)

HLM 1A DATA	LLM 1A DATA	LLM 2A DATA	HLM 1B DATA	LLM 1B DATA	LLM 2B DATA	AACS DATA	SPARE	P1	P2	P3	P4	P5	P6	P7	P8	P9
40	48	16	40	48	16	128	8	40	40	40	40	40	40	40	40	40

Figure A2.2.1. Engineering Data

A2.2.1 Measurement Position Identification. In order to assign measurements to the engineering data allocation, it is necessary to describe the structure and placement of measurements on the structure. The description must support the ability to command commutation map changes and to identify measurement position within the structure.

Within the fixed area and variable area, the structure location shall be as described in the following paragraphs.

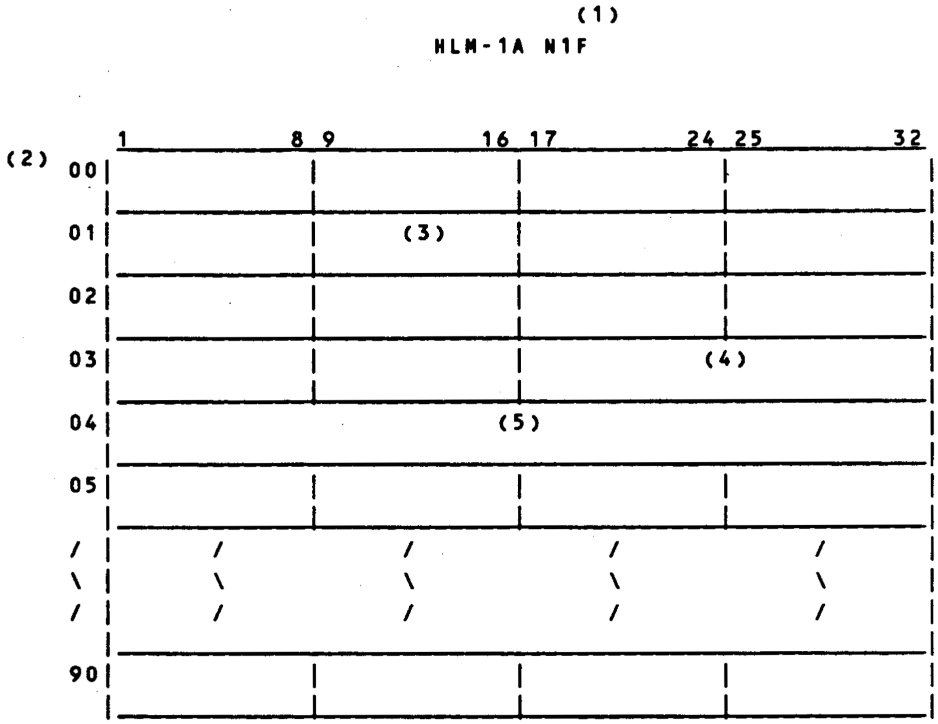
A2.2.1.1 Fixed-Area Allocation. Using the example in Figure A2.2.2 from HLM1A, the resulting structure and rules for creating the structure identifiers are highlighted.

The rules and legal values for creating the identifiers are shown in Table A2.2.2.

Table A2.2.1. Engineering Data

Data Description	Bits Frame	Offset to Data Start	Paragraph
High Level Module (HLM)1A Data	40	0	A2.2.2
Low Level Module (LLM)1A Data	48	40	A2.2.3
LLM 2A Data	16	88	A2.2.4
HLM 1B Data	40	104	A2.2.5
LLM 1B Data	48	144	A2.2.6
LLM 2B Data	16	192	A2.2.7
AACS Data	128	208	A2.2.8
spare	8	336	
Packet-1	40	344	A2.2.11
Packet-2	40	384	A2.2.11
Packet-3	40	424	A2.2.11
Packet-4	40	464	A2.2.11
Packet-5	40	504	A2.2.11
Packet-6	40	544	A2.2.11
Packet-7	40	584	A2.2.11
Packet-8	40	624	A2.2.11
Packet-9	40	664	A2.2.11

	704		



NOTES: (1) THIS SUBCOM (N1F) IS OF LENGTH 91 ("N"), IS THE FIRST SUBCOM OF THIS TYPE IN HLM1A ("1"), AND IS FOUR BYTES WIDE.

(2) THIS IDENTIFIES THE SUBCOM POSITION.

(3) A MEASUREMENT IN THIS POSITION IS IDENTIFIED AS HLM1A N1F01 2.

(4) A MEASUREMENT IN THIS POSITION IS IDENTIFIED AS HLM1A N1F03 3. THE MEASUREMENT CONSISTS OF 16 BITS.

(5) A MEASUREMENT IN THIS POSITION IS IDENTIFIED AS HLM1A N1F04 1. THE MEASUREMENT CONSISTS OF 32 BITS.

Figure A2.2.2. Fixed Area Structure/Position Identifiers

Table A2.2.2. Fixed Area Structure/Position Identifiers

Item	Item Identifier	Contents	Meaning	Comments
1.	Module ID	AACS HLM1A HLM1B LLM1A LLM1B LLM2A LLM2B		Identifies the module which creates the fixed area packet.
2.	Commutation Deck Length	Z S T N	One Seven Thirteen Ninety One	Indicates the repetition cycle of the data; e.g., every "n"th frame.
3.	Number of Commutation Deck of this Type	$1 \leq m \leq M$		Sequential number of commutator deck length and width (items 2 and 4).
4.	Commutation Deck Width	S D F	Single Byte Double Byte Four Byte	Width of Structure
5.	Position in Commutator Deck	See Comments		Item 2 — Maximum Value Z — 0 S — 6 T — 12 N — 90
6.	Measurement Characteristic	1 2 3 4	First Byte Second Byte Third Byte Fourth Byte	In multiple byte subcoms, this indicates the position of the measurement in the subcom. Measurements consisting of more than one byte are identified by the position of the most significant byte.

A2.2.1.2 <u>Variable-Area Allocation.</u> Using the example in Figure A2.2.3 for a typical AACS variable area packet, the resulting structure and the rules for creating the structure/position identifiers are highlighted.

The rules and allowed values for creating the identifiers are shown in Table A2.2.3.

```
          PACKET
                (1)
        AACS-V09S

          -------
         |       |
         |   1   |
         |_______|
    P    |    (2)|
    O    |   2   |
    S    |_______|
    I    |       |
    T    |   3   |
    I    |_______|
    O    |       |
    N    |   4   |
         |_______|
         |       |
         |   5   |
         |_______|
```

NOTES
(1) THE ILLUSTRATED 5 BYTE PACKET IS THE NINTH ("09") VARIABLE ("V") PACKET FROM "AACS". EACH MEASUREMENT IS NOMINALLY ONE BYTE ("S").

(2) A MEASUREMENT IS PLACED IN POSITION "2" OF THE VARIABLE PACKET

(a) TO IDENTIFY A SINGLE BYTE ASSIGNMENT IN THIS LOCATION, THE POSITION IDENTIFIER IS
AACS-V09S2F

(b) TO IDENTIFY A TWO BYTE ASSIGNMENT IN THIS LOCATION, THE POSITION IDENTIFIER IS
AACS-V09S2D

(c) TO IDENTIFY ONE HALF OF A TWO BYTE ASSIGNMENT IN THIS LOCATION, THE POSITION IDENTIFIER IS
AACS-V09S2L (LEFT BYTE) OR
AACS-V09S2R (RIGHT BYTE)

Figure A2.2.3. Variable Area Packet Structure/Position Identifiers

Table A2.2.3. Variable Area Packet Structure/Position Identifiers

Item	Identifier	Contents	Meaning	Comments
1	Module ID	AACS HLM 1A HLM 1B LLM 1A LLM 1B LLM 2A LLM 2B		Identifies the module which creates the variable area packet
2	Variable Packet	V	Variable area packet of length 5	Used to differentiate between fixed area and variable area packets
3	Packet number	$01 \le n \le 16$		Identifies the specific packet within the module of interest
4	Width	S	Single Byte	
		Description stops here if desire is to just identify packet. To identify a specific position, the remaining items are used.		
5	Packet Position	$1 \le$ positions ≤ 5		Position within packet
6	Measurement Characteristic	F	1 byte measurement	
		D	2 byte measurement	Packet position ≤ 4
		L	Left byte	Left byte of 2 byte measurement assigned to specific packet position
		R	Right byte	Right byte of 2 byte measurement assigned to specific packet position

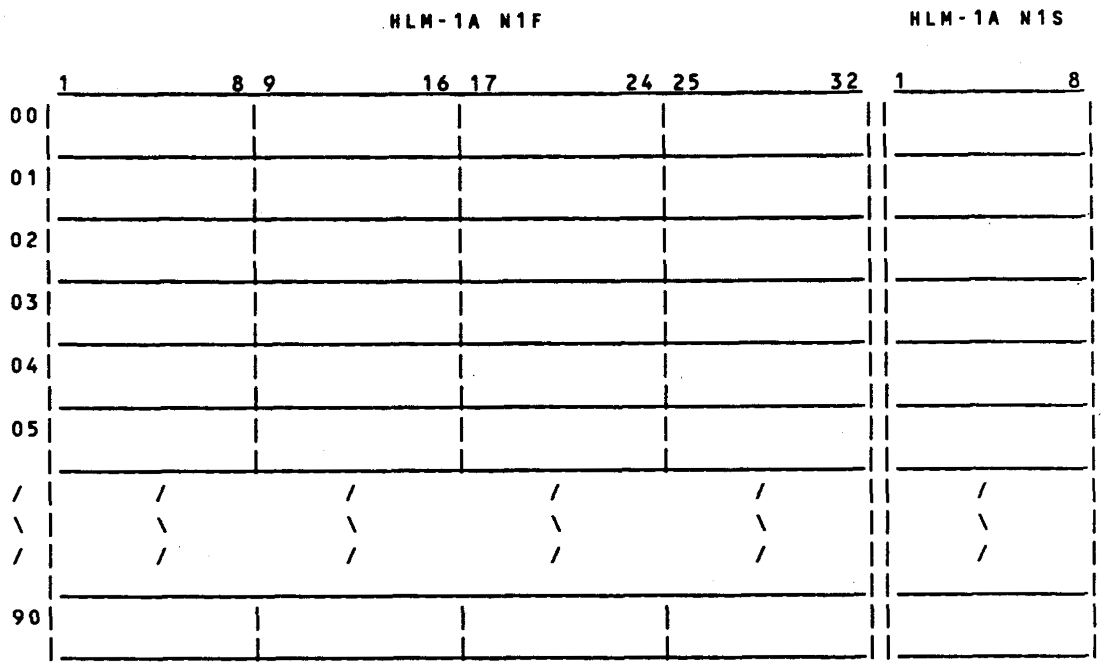


Figure A2.2.4. HLM 1A Data Packet

A2.2.2 High Level Module 1A Data Packet. The fixed area allocation for HLM 1A shall contain those measurements created within or sampled by HLM 1A.

The structure associated with the HLM 1A data shall be as shown in Figure A2.2.4 (refer to paragraph A2.2.1.1 for the interpretation of the identifiers shown in the figure).

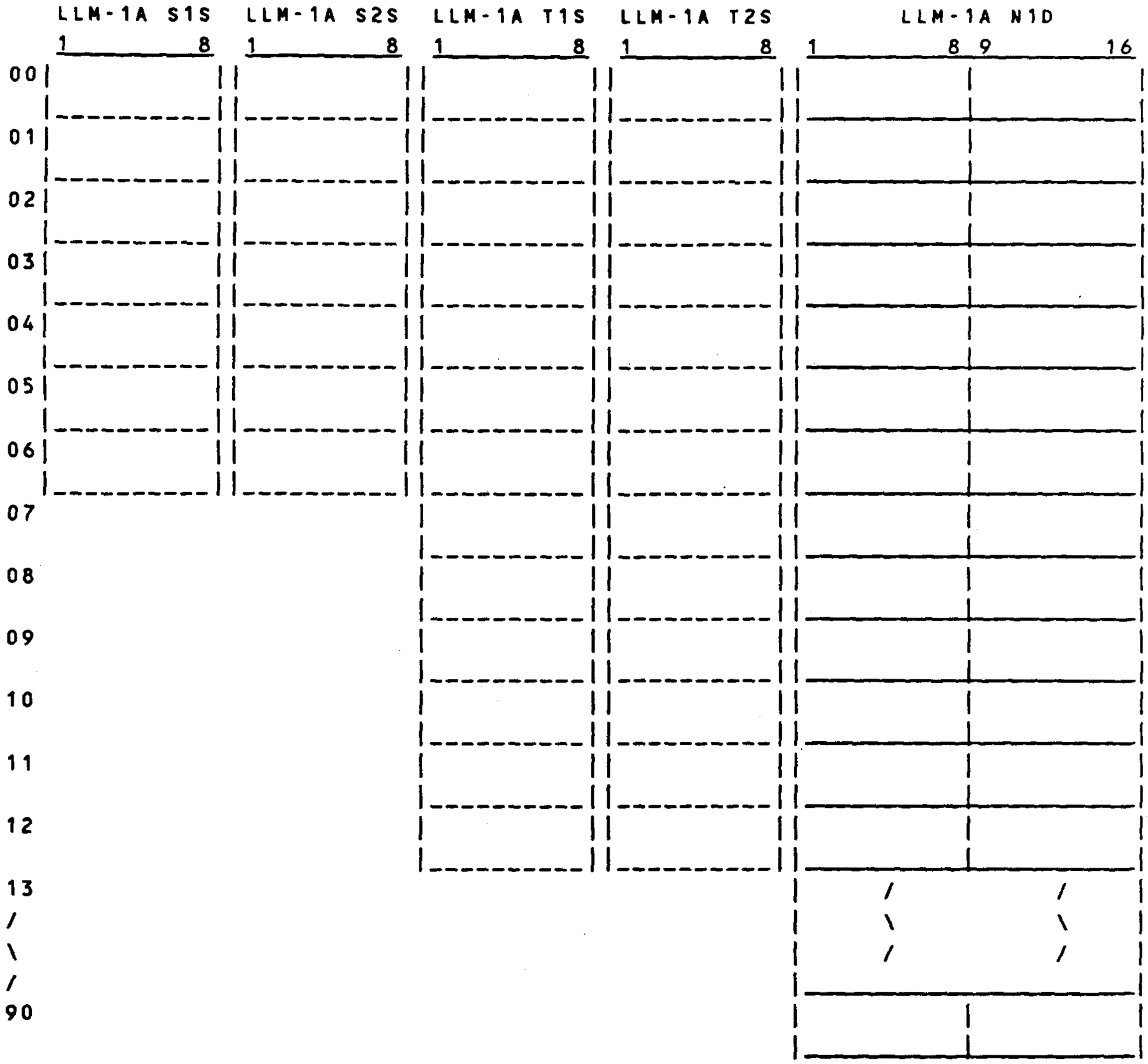


Figure A2.2.5. LLM 1A Data Packet

A2.2.3 <u>Low Level Module 1A Data Packet.</u> The fixed area allocation for LLM 1A shall contain those measurements created within or sampled by LLM 1A.

The structure associated with LLM 1A data shall be as shown by Figure A2.2.5 (refer to paragraph A2.2.1.1 for the interpretation of the identifiers shown on the figure).

LLM-2A N1D

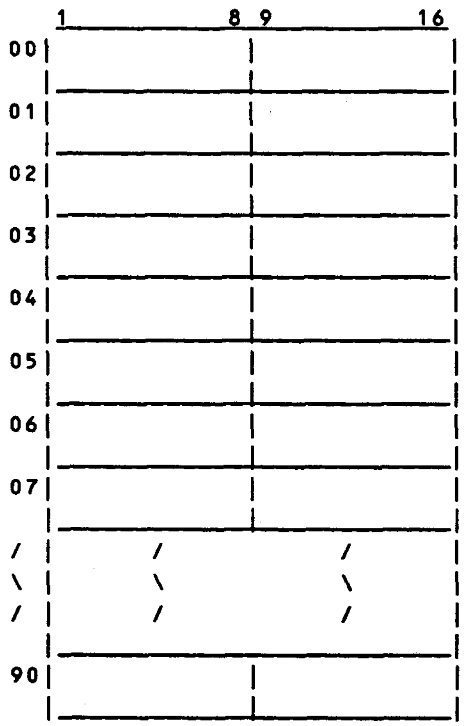


Figure A2.2.6. LLM 2A Data Packet

A2.2.4 Low Level Module 2A Data Packet. The fixed area allocation for LLM 2A shall contain those digital or software measurements created within or sampled by LLM 2A. Analog measurements on the despun side of the spacecraft shall be sampled by either LLM 2A or LLM 2B depending on the spacecraft hardware configuration.

The structure associated with LLM 2A data shall be as shown by the Figure A2.2.6 (refer to paragraph A2.2.1.1 for the interpretation of the identifiers shown on the figure).

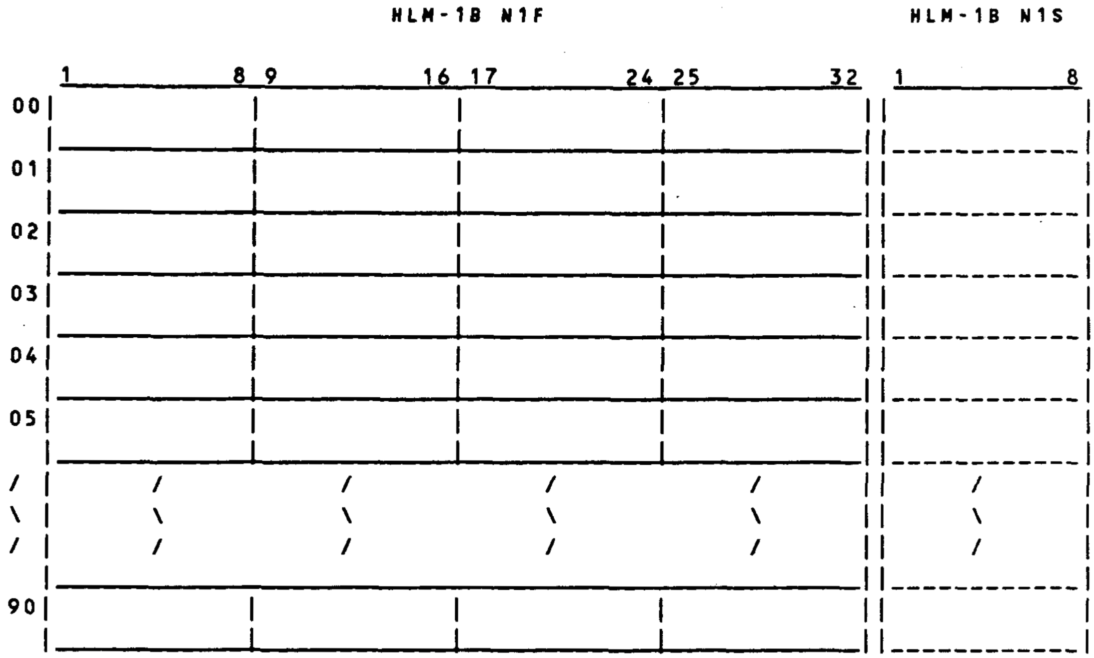


Figure A2.2.7. HLM 1B Data Packet

A2.2.5 <u>High Level Module 1B Data Packet.</u> The fixed area allocation for HLM 1B shall contain those measurements created within or sampled by HLM 1B.

The structure associated with HLM 1B data shall be as shown by Figure A2.2.7 (refer to paragraph A2.2.1.1 for the interpretation of the identifiers shown in the figure).

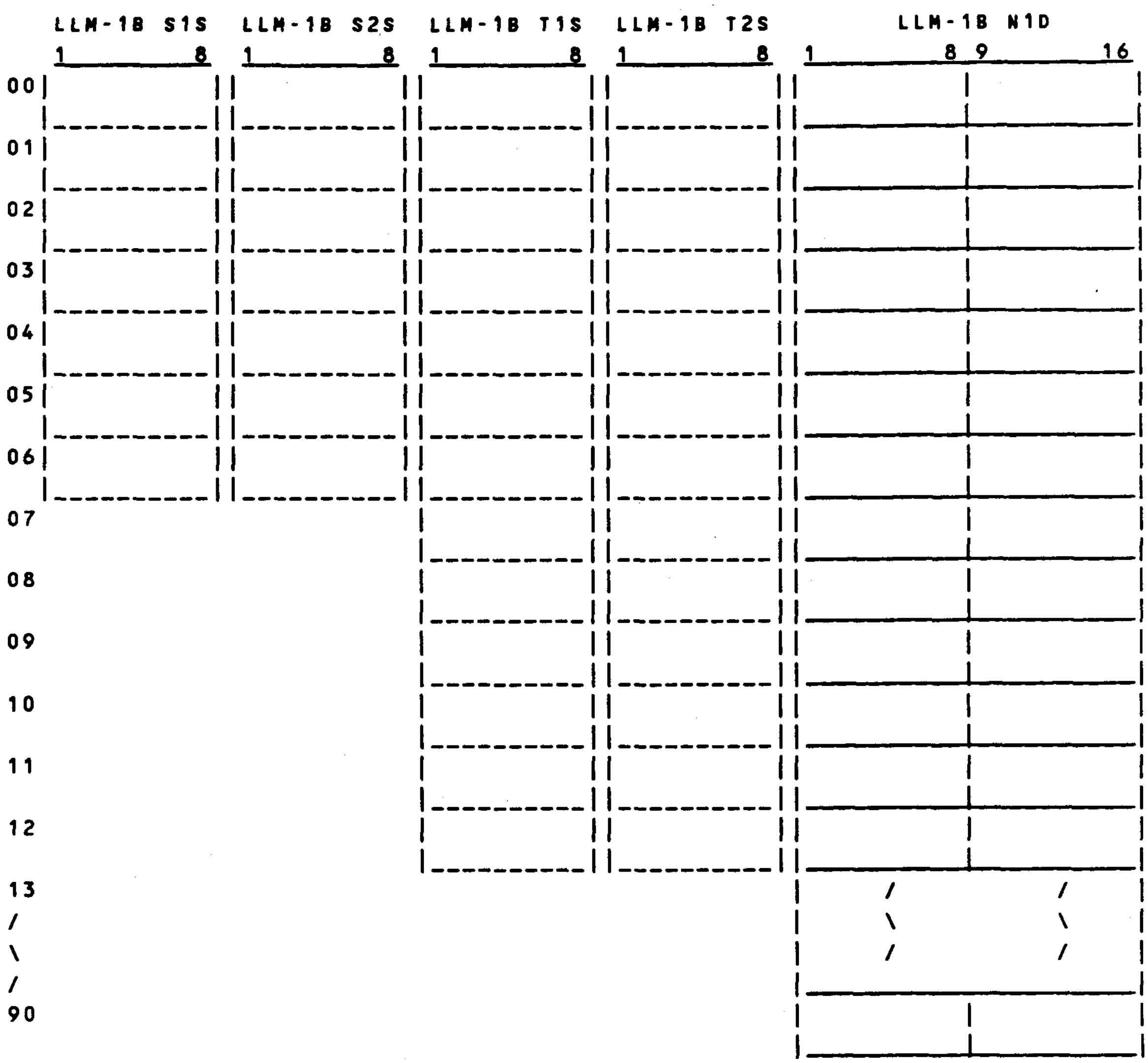


Figure A2.2.8. LLM 1B Data Packet

A2.2.6 <u>Low Level Module 1B Data Packet.</u> The fixed area allocation for LLM 1B shall contain those measurements created within or sampled by LLM 1B.

The structure associated with LLM 1B data shall be as shown by the Figure A2.2.8 (refer to paragraph A2.2.1.1 for the interpretation of the identifiers shown on the figure).

LLM-2B N1D

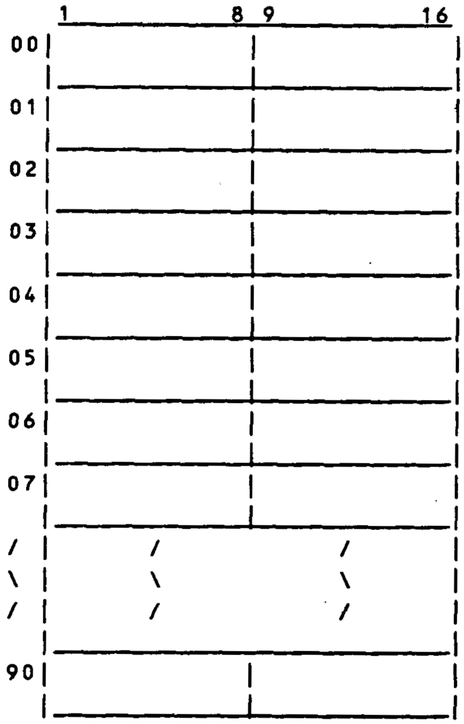


Figure A2.2.9. LLM 2B Data Packet

A2.2.7 Low Level Module 2B Data Packet. The fixed allocation for LLM 2B shall contain those digital or software measurements created within or sampled by LLM 2B. Analog measurements on the despun side of the spacecraft shall be sampled by either LLM 2A or LLM 2B depending on the spacecraft hardware configuration.

The structure associated with LLM 2B data shall be as shown by the Figure A2.2.9 (refer to paragraph A2.2.1.1 for the interpretation of the identifiers shown in the figure).

```
     1____16 1____16 1____16 1____16 1____16 1____16 1____16 1__8 1__8
00  |       ||       ||       ||       ||       ||       ||       ||    ||    |
    |_______||_______||_______||_______||_______||_______||_______||____||____|
01  |       ||       ||       ||       ||       |
    |_______||_______||_______||_______||_______|
02  |       ||       ||       ||       ||       |
    |_______||_______||_______||_______||_______|
03  |       ||       ||       ||       ||       |
    |_______||_______||_______||_______||_______|
04  |       ||       ||       ||       ||       |
    |_______||_______||_______||_______||_______|
05  |       ||       ||       ||       ||       |
    |_______||_______||_______||_______||_______|
06  |       ||       ||       ||       ||       |
    |_______||_______||_______||_______||_______|
07  |       ||       ||       ||       ||       |
    |_______||_______||_______||_______||_______|
08  |       ||       ||       ||       ||       |
    |_______||_______||_______||_______||_______|
09  |       ||       ||       ||       ||       |
    |_______||_______||_______||_______||_______|
10  |       ||       ||       ||       ||       |
    |_______||_______||_______||_______||_______|
11  |       ||       ||       ||       ||       |
    |_______||_______||_______||_______||_______|
12  |       ||       ||       ||       ||       |
    |_______||_______||_______||_______||_______|
13                            |       ||       |
                              |_______||_______|
14                            |       ||       |
                              |_______||_______|
15                            |       ||       |
                              |_______||_______|
/                             |   /   ||   /   |
\                             |   \   ||   \   |
/                             |   /   ||   /   |
                              |_______||_______|
90                            |       ||       |
                              |_______||_______|
```

Figure A2.2.10. AACS Data Packet

A2.2.8 <u>Attitude and Articulation Control Subsystem Data Packet.</u> The fixed area allocation for the AACS shall contain those measurements created within or sampled by AACS.

The structure associated with AACS data shall be as shown by Figure A2.2.10 (refer to paragraph A2.2.1.1 for the interpretation of the identifiers shown in the figure).

A2.2.9 DELETED

A2.2.10 DELETED

MODULE-VnnS

1 ... 40

POSITION NUMBER	1	2	3	4	5
BITS	8	8	8	8	8

Figure A2.2.11. Variable Packet

A2.2.11 <u>Variable Area Packets.</u> The variable area packets shall be identical in structure within each of the CDS and AACS computer modules. These packets shall accommodate the various mission phase differences in measurement sampling requirements.

The structure associated with each packet shall be as shown in Figure A2.2.11 (refer to paragraph A2.2.1.2 for the interpretation of the identifiers shown in the figure).

In any variable packet it shall be prohibited to create subcommutators within any position of the packet. There shall be no restriction as to the measurements which may be assigned to these packets.

A2.2.12 <u>Measurement Sampling Times.</u> The measurements placed into the engineering packet shall be sampled as specified in the succeeding paragraphs.

A2.2.12.1 <u>Fixed Area Measurement Timing: CDS.</u> Data sampled by a CDS High Level Module shall be sampled as specified in A2.2.12.1.1. Data sampled by a CDS Low Level Module shall be sampled as specified in A2.2.12.1.2.

A2.2.12.1.1 CDS High Level Module Sampling. Within the CDS, the data subcommutated into the HLM area of an engineering frame shall have been sampled during the MOD91=89 of the RIM previous to the RIM contained in the header.

A2.2.12.1.2 CDS Low Level Module Sampling. Within the CDS, software measurements subcommutated into the LLM area of an engineering frame shall have been sampled during the MOD91=89 of the RIM previous to the RIM contained in the header. The exceptions are the DMS Position Estimates (E-0423. E-0424, E-0923, and E-0924), and the Discharge Controller Use Counter (E-0089). These are sampled in the MOD91 previous to the MOD91 contained in the header. Hardware measurements (Analog, Digital, and Temperature) shall be sampled as shown in Table A2.2.4.

Table A2.2.4. CDS Fixed Area Measurement Sampling Time
(Milliseconds offset prior to SCLK)

Telemetry Mode	Rate b/s	Subcommutation Deck S1S	S2S	T1S	T2S	N1D Left Byte	N1D Right Byte
1200 b/s	1200	646-2/3	580	446-2/3	380	246-2/3	180

Table A2.2.5. CDS Variable Packet Measurement Sampling Time
(milliseconds offset prior to SCLK)

Packet(1) Timing Position	Position Within Packet 1	2	3	4	5
A	666-2/3	533-1/3	400	266-2/3	133-1/3
B	633-1/3	500	366-2/3	233-1/3	100
C	600	466-2/3	333-1/3	200	66-2/3
D	566-2/3	433-1/3	300	166-2/3	33-1/3
E	653-1/3	520	386-2/3	253-1/3	120
F	606-2/3	473-1/3	340	206-2/3	73-1/3
G	586-2/3	453-1/3	320	186-2/3	53-1/3
H	540	406-2/3	273-1/3	140	6-2/3
I	460	440	426-2/3	420	413-1/3

(1) In creating an engineering map, any of the packets ($01 \leq n \leq 16$) within a module may be assigned to the packet timing position A, B, C, D, E, F, G, H, or I.

A2.2.12.2 <u>Variable Packet Measurement Timing: CDS.</u> Within any CDS module creating variable area packets, the sample time relationship shown in Table A2.2.5 shall be maintained.

A2.2.12.3 Measurement Timing: AACS. Within the AACS, the data sampling shall occur during RTI 0 (MOD 10=0).

Table A2.2.6

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A2.2.13 S/C High Rate Sampling.

A2.2.13.1 CDS Single Identifier (SID) Mode. In order to assist in the investigation of spacecraft anomalies, it shall be possible to replace all of the variable engineering data with a single measurement. The measurement will be placed in all five positions of a packet, and then that packet shall occupy all timing positions shown in Table A2.2.5.

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A2.2.13.2 AACS Flood Mode. The AACS shall not be required to originate single-ID telemetry (hog-mode). Instead, for calibration of more volatile AACS measurements, a calibration measurement readout, popularly called "flood-mode" telemetry, shall be provided. The AACS shall at all times collect 6 measurements, in a 61 word rotating buffer, every 66 2/3 msec. The 6 measurements to be collected shall be capable of being specified by uplink commands. The MSS shall be provided with the ability to collect the AACS calibration buffer from the AACS and accumulate it in a larger buffer in the CDS once every 2/3 sec. for a period of up to 28 seconds, by means of an uplinked command sequence. Then the accumulated CDS buffer shall be transmitted to the ground by means of the standard memory readout telemetry capability, as the final step in the command sequence. The scheduling of a calibration readout sequence shall be constrained by other sequencing events to those periods when the CDS accumulation buffer can be made available.

A2.2.14 Engineering Measurements and Formats

This section identifies the GLL engineering measurements, engineering formats, and commutator position assignments of each measurement within the engineering formats.

A2.2.14.1 Engineering Measurement Detailed Data

Table A2.2.8 provides detailed data for each engineering measurement. This data includes measurement engineering number (E-No.), title, identification (treeswitch or other identification, as appropriate), engineering unit range, number of bits, and type (analog/temperature/digital/software).

The table headings are as follows: NUMBER refers to engineering number. MEASUREMENT TITLE is the name of the measurement. ENGINEERING RANGE refers to the engineering range of the measurement, with degrees given in Celsius for temperature measurements. TREE POS refers to the hardware treeswitch position. COMM POS refers to the position in the engineering commutator, and therefore the frequency of sampling, of engineering measurements. NO. OF BITS indicates how many bits the measurement contains. FLAGS refers to 2 flags, with the first flag (F, V, or B) referring to whether the measurement is in the fixed commutator area only, the variable commutator area only, or both. The second flag (A, T, D, or S) denotes whether the measurement is an analog measurement, a temperature measurement, a digital measurement, or a software measurement.

Digital and Software bit definitions are shown in Table A2.2.9.

Eight despun measurements are multiplexed into the back-up despun measurement (BDM) channels (E-1109, E-1110, E-1129, E-1130). The multiplexing is controlled using 3 bits in the despun CRC registers known as the "Despun CRC backup mux select bits A, B, and C" as shown in Table A2.2.7.

Table A2.2.7. Backup Multiplexed Measurements

DESPUN CRC BACK-UP MUX SELECT BIT			CHANNEL ASSIGNMENT	MEASUREMENT SELECTED
C	B	A		
0	0	0	BDM 00	RRA position pot. 2
0	0	1	BDM 01	spare measurement
0	1	0	BDM 02	CDS +3VDC to RRA pot. 1
0	1	1	BDM 03	CDS despun commutator tree out
1	0	0	BDM 04	CDS despun signal ground
1	0	1	BDM 05	CDS filter calibration voltage
1	1	0	BDM 06	Unused
1	1	1	BDM 07	Unused

Measurements from the contamination monitor are multiplexed through channel E-0016. The CM's multiplexer is unsynched to the CDS and utilyzes two reference voltage states (0 and 3 volts) at the start of each data cycle to enable MOS to reconstruct the data. Each CM multiplexer state lasts for 3 minutes. The multiplexer states are described in Table A2.2.7A.

Table A2.2.7A CM Multiplexed Measurements

Multiplexer State	Measurement
0	0 volt reference (used to sync CM data)
1	3 volt reference (used to sync CM data)
2	QCM 1 output frequency
3	QCM 1 temperature measurement
4	QCM 2 output frequency
5	QCM 2 temperature measurement
6	QCM 3 output frequency
7	QCM 3 temperature measurement

Table A2.2.8. Engineering Measurements
IUS - IUS SUBSYSTEM

S/S # IUS

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS		COMM POS	NO. OF BITS	FLAGS	
E-1665	IUS STATUS WORD 1		T2A	00		8	V	D
E-1666	IUS STATUS WORD 2		T2B	00		8	V	D

Table A2.2.8. Engineering Measurements
STRU - STRUCTURE SYSTEM

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE		TREE POS		COMM POS			NO. OF BITS	FLAGS	
E-0000	BAY 1 TEMPERATURE	-78. TO 100.	DEG	T1A	5E	LLM1A	N1D16	1	8	F	T
E-0001	BAY 2 TEMPERATURE	-78. TO 100.	DEG	T1B	5E	LLM1B	N1D16	1	8	F	T
E-0002	BAY 3 TEMPERATURE	-78. TO 100.	DEG	T1A	76	LLM1A	N1D16	2	8	F	T
E-0003	BAY 4 TEMPERATURE	-78. TO 100.	DEG	T1B	66	LLM1B	N1D16	2	8	F	T
E-0004	BAY 5 TEMPERATURE	-78. TO 100.	DEG	T1A	6A	LLM1A	N1D17	1	8	F	T
E-0005	BAY 6 TEMPERATURE	-78. TO 100.	DEG	T1B	77	LLM1B	N1D17	1	8	F	T
E-0006	BAY 7 TEMPERATURE	-78. TO 100.	DEG	T1A	7E	LLM1A	N1D17	2	8	F	T
E-0007	BAY 8 TEMPERATURE	-78. TO 100.	DEG	T1B	7E	LLM1B	N1D17	2	8	F	T
E-0008	SCAN PLATFORM TEMPERATURE	-102. TO 74.	DEG	T2A	5C	LLM2A	N1D20	1	8	F	T
E-0009	DESPUN STRUCTURE 2 TEMPERATURE	-78. TO 100.	DEG	T2A	53	LLM2A	N1D42	2	8	F	T
E-0010	BAY A TEMPERATURE	-78. TO 100.	DEG	T2A	77	LLM2A	N1D32	1	8	F	T
E-0011	BAY B TEMPERATURE	-78. TO 100.	DEG	T2A	5B	LLM2A	N1D32	2	8	F	T
E-0012	BAY C TEMPERATURE	-78. TO 100.	DEG	T2A	66	LLM2A	N1D72	1	8	F	T
E-0013	BAY D TEMPERATURE	-78. TO 100.	DEG	T2A	7B	LLM2A	N1D71	1	8	F	T
E-0014	BAY E TEMPERATURE	-78. TO 100.	DEG	T2A	67	LLM2A	N1D72	2	8	F	T
E-0015	DESPUN STRUCTURE 1 TEMPERATURE	-78. TO 100.	DEG	T2A	6E	LLM2A	N1D71	2	8	F	T
E-0016	CONTAMINATION MONITOR TELEMETRY	0 TO 3	VDC	T1B	36	LLM1B	N1D42	1	8	F	A
E-0017	SUNGATE TEMPERATURE	-102. TO 74.	DEG	T1B	73	LLM1B	N1D71	1	8	F	T

Table A2.2.8. Engineering Measurements
RFS - RADIO FREQUENCY SUBSYSTEM

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE		TREE POS		COMM POS	NO. OF BITS	FLAGS	
E-0018	RFS/PPS STATUS WORD 1			T1A	00	LLM1A T2S05 1	8	F	D
E-0019	RFS/PPS STATUS WORD 2			T1B	00	LLM1B T1S07 1	8	F	D
E-0020	RFS STATUS WORD 1 A			T1A	08	LLM1A T2S08 1	8	F	D
E-0021	RFS STATUS WORD 2 B			T1B	09	LLM1B T1S02 1	8	F	D
E-0022	RECEIVER 1/2 VCO VOLTAGE COARSE	-75. TO +75.	KHZ	T1B	33	LLM1B S2S04 1	8	B	A
E-0023	RECEIVER 1/2 VCO VOLTAGE FINE	-30. TO +30.	KHZ	T1A	46	LLM1A S2S04 1	8	B	A
E-0024	RECEIVER AGC A	-70. TO -152.	DBM	T1A	33	LLM1A S1S04 1	8	B	A
E-0025	RECEIVER AGC B	-70. TO -152.	DBM	T1B	38	LLM1B S1S04 1	8	B	A
E-0026	RECEIVER RANGING AGC VOLTAGE	-70. TO -152.	DBM	T1B	46	LLM1B T1S04 1	8	B	A
E-0027	RECEIVER CURRENT	0. TO 225.	MA	T1B	24	LLM1B T1S10 1	8	B	A
E-0028	RECEIVER LOCAL OSCILATOR DRIVE	0. TO 6.	DBM	T1A	4C	LLM1A N1D00 2	8	B	A
E-0029	USO INNER OVEN CURRENT	0. TO 50.	MA	T1B	2D	LLM1B T2S09 1	8	F	A
E-0030	S-BAND TWT REGULATED VOLTAGE	0. TO 25.	V	T1A	1B	LLM1A T1S04 1	8	F	A
E-0031	S-BAND TWT DRIVE	-4. TO +8.	DBM	T1A	24	LLM1A T1S10 1	8	B	A
E-0032	S-BAND TWT CATHODE CURRENT	0. TO 80.	MA	T1A	2A	LLM1A T1S09 1	8	F	A
E-0033	S-BAND TWT HELIX CURRENT	0. TO 20.	MA	T1B	3B	LLM1B T1S09 1	8	F	A
E-0034	LOW-GAIN ANTENNA DRIVE	+27. TO +45.	DBM	T1A	2D	LLM1A T1S05 1	8	B	A
E-0035	S-BAND HIGH GAIN ANTENNA DRIVE	+27. TO +45	DBM	T1B	4C	LLM1B T2S11 1	8	B	A
E-0036	S-BAND EXCITER CURRENT	0. TO 110.	MA	T1B	41	LLM1B T1S11 1	8	F	A
E-0037	X-BAND TWT REGULATED VOLTAGE	0. TO 25.	V	T1B	2A	LLM1B T2S10 1	8	F	A
E-0038	X-BAND TWT DRIVE	-6. TO +6.	DBM	T1A	38	LLM1A T2S11 1	8	B	A
E-0039	X-BAND TWT HELIX CURRENT	0. TO 8.	MA	T1A	1C	LLM1A T2S04 1	8	F	A
E-0040	X-BAND TWT CATHODE CURRENT	0. TO 60.	MA	T1B	1B	LLM1B T2S04 1	8	F	A
E-0041	X-BAND EXCITER CURRENT	0. TO 160.	MA	T1B	21	LLM1B T2S05 1	8	F	A
E-0042	X-BAND HIGH GAIN ANTENNA DRIVE	+30. TO +44.	W	T1A	19	LLM1A T2S09 1	8	B	A

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Table A2.2.8. Engineering Measurements
RFS - RADIO FREQUENCY SUBSYSTEM

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE		TREE POS	COMM POS	NO. OF BITS	FLAGS
E-0043	RECEIVER VCO TEMPERATURE	-78. TO 100.	DEG	T1A 57	LLM1A N1D70 1	8	F T
E-0044	S-BAND TWT BASE TEMPERATURE	-68. TO 148.	DEG	T1A 61	LLM1A N1D70 2	8	F T
E-0045	S-BAND HYBRID TEMPERATURE	-78. TO 100.	DEG	T1A 5B	LLM1A N1D27 2	8	F T
E-0046	X-BAND TWT BASE TEMPERATURE	-68. TO 148.	DEG	T1B 61	LLM1B N1D70 2	8	F T
E-0047	X-BAND HYBRID TEMPERATURE	-78. TO 100.	DEG	T1A 77	LLM1A N1D71 1	8	F T
E-0048	X-BAND RF MONITOR TEMPERATURE	-78. TO 100.	DEG	T1A 67	LLM1A N1D71 2	8	F T
E-0049	X-BAND EXCITER TEMPERATURE	-78. TO 100.	DEG	T1B 6E	LLM1B N1D71 2	8	F T
E-0050	TRANSMITTER RF SWITCH TEMPERATURE	-78. TO 100.	DEG	T1B 5B	LLM1B N1D70 1	8	F T
E-0051	AUXILLIARY OSCILLATOR TEMPERATURE	-78. TO 100.	DEG	T1B 67	LLM1B N1D68 1	8	F T
E-0052	RFS STATUS WORD 1B			T1B 08	LLM1B N1D01 1	8	F D
E-0053	RFS STATUS WORD 2A			T1A 09	LLM1A N1D01 2	8	F D
E-1551	LGA RECEIVER SW STATUS	0. TO 3.	V	T1A 36	LLM1A N1D44 1	8	F A
E-1552	LGA POWER SUPPLY 1 CURRENT	0. TO 3.	V	T1A 37	LLM1A N1D45 1	8	F A
E-1553	LGA POWER SUPPLY 2 CURRENT	0. TO 3.	V	T1B 31	LLM1B N1D45 2	8	F A
E-1556	LGA TRANSMITTER SW STATUS	0. TO 3.	V	T1B 42	LLM1B N1D45 1	8	F A
E-1557	LGA TRANSMITTER SW TEMPERATURE	-102. TO +74.	DEG	T1A 6E	LLM1A N1D44 2	8	F A

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Table A2.2.8. Engineering Measurements
MDS - MODULATION DEMODULATION SUBSYSTEM

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS	COMM POS	NO. OF BITS	FLAGS
E-0055	TMU STATUS WORD 1 (A)		T1A 0A	LLM1A T1S06 1	8	F D
E-0056	TMU STATUS WORD 2 (A)		T1A 0B	LLM1A T2S06 1	8	F D
E-0057	CDU SIGNAL TO NOISE RATIO MSB A		T1A 04		8	D
E-0057	CDU SIGNAL TO NOISE RATIO LSB A		T1A 05		8	D
E-0058	CDU OSCILLATOR MONITOR A		T1A 03	LLM1A N1D78 1	8	F D
E-0059	TMU STATUS WORD 1 (B)		T1B 0A	LLM1B T1S06 1	8	F D
E-0060	TMU STATUS WORD 2 (B)		T1B 0B	LLM1B T2S06 1	8	F D
E-0061	CDU SIGNAL TO NOISE RATIO MSB B		T1B 04		8	D
E-0061	CDU SIGNAL TO NOISE RATIO LSB B		T1B 05		8	D
E-0062	CDU OSCILLATOR MONITOR B		T1B 03	LLM1B N1D78 1	8	F D
E-0065	PPS/MDS/CDS STATUS WORD 1		T1A 01	LLM1A S2S06 1	8	B D
E-0066	PPS/MDS/CDS STATUS WORD 2		T1B 01	LLM1B S2S06 1	8	B D

Table A2.2.8. Engineering Measurements
PPS - POWER/PYRO SUBSYSTEM

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NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE		TREE POS		COMM POS	NO. OF BITS	FLAGS	
E-0018	RFS/PPS STATUS WORD 1			T1A	00	LLM1A T2S05 1	8	F	D
E-0019	RFS/PPS STATUS WORD 2			T1B	00	LLM1B T1S07 1	8	F	D
E-0065	PPS/MDS/CDS STATUS WORD 1			T1A	01	LLM1A S2S06 1	8	B	D
E-0066	PPS/MDS/CDS STATUS WORD 2			T1B	01	LLM1B S2S06 1	8	B	D
E-0067	PPS/DEV/PRB/UVS STATUS WORD			T2A	01		8	V	D
E-0068	PPS/DEV/PRB STATUS WORD			T2B	01		8	V	D
E-0069	+X RTG OUTPUT VOLTAGE	0. TO 35.	VDC	T1A	4A	LLM1A N1D84 1	8	F	A
E-0070	-X RTG OUTPUT VOLTAGE	0. TO 35.	VDC	T1B	27	LLM1B N1D84 1	8	F	A
E-0071	PROBE POWER INTERFACE UNIT A MAIN BUS DC VOLTAGE	0. TO 40.	VDC	T2A	15	LLM2A N1D81 1	8	F	A
E-0072	PROBE POWER INTERFACE UNIT A DCP BUS DC VOLTAGE	0. TO 40.	DCV	T2A	28	LLM2A N1D81 2	8	F	A
E-0073	-X RTG OUTPUT CURRENT	0. TO 10.	ADC	T1A	3C	LLM1A N1D01 1	8	F	A
E-0074	PROBE POWER INTERFACE UNIT A CCD BUS DC VOLTAGE	0. TO 40.	DCV	T2A	3C	LLM2A N1D82 1	8	F	A
E-0075	+X RTG OUTPUT CURRENT	0. TO 10.	ADC	T1B	4A	LLM1B N1D01 2	8	F	A
E-0076	PROBE POWER INTERFACE UNIT B MAIN BUS DC VOLTAGE	0. TO 40.	VDC	T2A	4D	LLM2A N1D82 2	8	F	A
E-0077	PROBE POWER INTERFACE UNIT B DCP BUS DC VOLTAGE	0. TO 40.	VDC	T2A	26	LLM2A N1D83 1	8	F	A
E-0078	DC BUS VOLTAGE	0. TO 35.	VDC	T1A	1D	LLM1A T2S02 1	8	B	A
E-0079	PROBE POWER INTERFACE UNIT B CCD BUS DC VOLTAGE	0. TO 40.	DCV	T2A	37	LLM2A N1D83 2	8	F	A
E-0080	SHUNT REGULATOR INPUT CURRENT A (LF)	0. TO 10.	ADC	T1A	18	LLM1A T1S02 1	8	B	A
E-0081	SHUNT REGULATOR INPUT CURRENT B (HF)	0. TO 10.	ADC	T1B	18	LLM1B T2S07 1	8	F	A
E-0082	DC BUS CURRENT A	0. TO 15.	ADC	T1A	23	LLM1A S2S03 1	8	F	A
E-0083	DC BUS CURRENT B	0. TO 15.	ADC	T1B	23	LLM1B S2S03 1	8	B	A
E-0086	2.4 KHZ INVERTER OUTPUT CURRENT	0. TO 6.	AAC	T1A	3E	LLM1A T1S07 1	8	B	A
E-0086						LLM1A T1S11 1	0		
E-0087	2.4 KHZ INVERTER INPUT CURRENT	0. TO 10.	ADC	T1B	43	LLM1B T2S08 1	8	F	A
E-0088	2.4 KHZ INVERTER OUTPUT VOLTAGE	40. TO 60.	VAC	T1B	34	LLM1B N1D00 1	8	F	A

Table A2.2.8. Engineering Measurements
PPS - POWER/PYRO SUBSYSTEM

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE		TREE POS		COMM POS	NO. OF BITS	FLAGS	
E-0088						LLM1B N1D44 1	0		
E-0089	DISCHARGE CONTROLLER USE COUNTER			L1A	FF	LLM1A N1D65 1	8	F	S
E-0090	PYRO BANK 1A VOLTAGE	0. TO 45.	VDC	T1A	40	LLM1A N1D43 2	8	B	A
E-0091	PYRO BANK 1B VOLTAGE	0. TO 45.	VDC	T1B	40	LLM1B N1D43 2	8	B	A
E-0092	PYRO BANK 2A VOLTAGE	0. TO 45.	VDC	T2A	18	LLM2A N1D46 1	8	B	A
E-0093	PYRO BANK 2B VOLTAGE	0. TO 45.	VDC	T2A	27	LLM2A N1D46 2	8	B	A
E-0094	DC BUS VOLTAGE IMBALANCE	0. TO 30.	VDC	T1B	2B	LLM1B N1D07 2	8	F	A
E-0094						LLM1B N1D20 2	0		
E-0094						LLM1B N1D33 2	0		
E-0094						LLM1B N1D46 2	0		
E-0094						LLM1B N1D59 2	0		
E-0094						LLM1B N1D72 2	0		
E-0094						LLM1B N1D85 2	0		
E-0095	AC BUS VOLTAGE IMBALANCE	-25. TO +25.	VRMS	T1A	2B	LLM1A N1D07 2	8	F	A
E-0095						LLM1A N1D20 2	0		
E-0095						LLM1A N1D33 2	0		
E-0095						LLM1A N1D46 2	0		
E-0095						LLM1A N1D59 2	0		
E-0095						LLM1A N1D72 2	0		
E-0095						LLM1A N1D85 2	0		
E-0096	SHUNT REGULATOR TEMPERATURE	-78. TO 100.	DEG	T1A	7B	LLM1A N1D78 2	8	F	T
E-0097	+X RTG CASE TEMPERATURE RTD 4	-9. TO 309.	DEG	T1A	54	LLM1A T1S03 1	8	F	T
E-0098	+X RTG CASE TEMPERATURE RTD 2	-9. TO 309.	DEG	T1B	6D	LLM1B T1S03 1	8	F	T
E-0099	-X RTG CASE TEMPERATURE RTD 4	-9. TO 309.	DEG	T1A	7D	LLM1A T2S03 1	8	F	T
E-0100	-X RTG CASE TEMPERATURE RTD 2	-9. TO 309.	DEG	T1B	59	LLM1B T2S03 1	8	F	T

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Table A2.2.8. Engineering Measurements
PPS - POWER/PYRO SUBSYSTEM

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE		TREE POS	COMM POS	NO. OF BITS	FLAGS	
E-0101	TLM Spare 6	TBD	VDC	T1B 19	LLM1B S1S01 1	8	F	A
E-0102	TLM Spare 7	TBD		T1B 1A	LLM1B S1S02 1	8	F	A
E-0103	TLM Spare 8	TBD		T1B 1C	LLM1B S1S03 1	8	F	A
E-0104	TLM Spare 9	TBD		T1B 1D	LLM1B S2S05 1	8	F	A
E-0105	TLM Spare 1	TBD		T1A 1E	LLM1A S1S01 1	8	F	A
E-0106	TLM Spare 11	TBD		T1B 22	LLM1B N1D65 1	8	F	A
E-0107	TLM Spare 2	TBD		T1A 21	LLM1A S1S02 1	8	F	A
E-0108	TLM Spare 3	TBD		T1A 22	LLM1A S1S03 1	8	F	A
E-0109	TLM Spare 4	TBD		T1A 26	LLM1A S2S05 1	8	F	A
E-1500	TLM Spare 10	TBD		T1B 26	LLM1B S1S05 1	8	F	A
E-1501	TLM Spare 5	TBD		T1A 27	LLM1A T1S08 1	8	F	A
E-1502	TLM Spare 14	TBD		T1A 5A	LLM1A N1D66 2	8	F	T
E-1503	TLM Spare 13	TBD		T1A 66	LLM1A N1D66 1	8	F	T
E-1504	TLM Spare 15	TBD		T1B 6A	LLM1B N1D66 2	8	F	T
E-1505	PDE 30VDC INHIBIT STATUS A	0. TO 3.	VDC	T1A 29	LLM1A T2S10 1	8	F	A
E-1506	TLM Spare 12	TBD		T1B 1E	LLM1B T1S08 1	8	F	A
E-1507	PDE 30VDC INHIBIT STATUS B	0. TO 3.	VDC	T1B 29	LLM1B N1D66 1	8	F	A

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Table A2.2.8. Engineering Measurements
CDS - COMMAND AND DATA SUBSYSTEM

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS	COMM POS	NO. OF BITS	FLAGS
E-0115	HLM1A LAST BC RIM COUNT		H1A 00	HLM1A N1F00 1	24	F S
E-0116	HLM1A LAST BC MOD91		H1A 00	HLM1A N1F00 4	8	F S
E-0117	HLM1A BC BUFFER ENTRY 1A		H1A 00	HLM1A N1F01 1	32	F S
E-0118	HLM1A BC BUFFER ENTRY 2A		H1A 00	HLM1A N1F02 1	32	F S
E-0119	HLM1A BC BUFFER ENTRY 3A		H1A 00	HLM1A N1F03 1	32	F S
E-0120	HLM1A BC BUFFER ENTRY 4A		H1A 00	HLM1A N1F04 1	32	F S
E-0121	HLM1A BC BUFFER ENTRY 5A		H1A 00	HLM1A N1F05 1	32	F S
E-0122	HLM1A BC BUFFER ENTRY 6A		H1A 00	HLM1A N1F06 1	32	F S
E-0123	HLM1A BC BUFFER ENTRY 7A		H1A 00	HLM1A N1F07 1	32	F S
E-0124	HLM1A BC BUFFER ENTRY 8A		H1A 00	HLM1A N1F08 1	32	F S
E-0125	HLM1A BC BUFFER ENTRY 9A		H1A 00	HLM1A N1F09 1	32	F S
E-0126	HLM1A BC BUFFER ENTRY 10A		H1A 00	HLM1A N1F10 1	32	F S
E-0127	HLM1A BC BUFFER ENTRY 11A		H1A 00	HLM1A N1F11 1	32	F S
E-0128	HLM1A BC BUFFER ENTRY 12A		H1A 00	HLM1A N1F12 1	32	F S
E-0129	HLM1A BC BUFFER ENTRY 13A		H1A 00	HLM1A N1F13 1	32	F S
E-0130	HLM1A BC BUFFER ENTRY 14A		H1A 00	HLM1A N1F14 1	32	F S
E-0131	HLM1A BC BUFFER ENTRY 15A		H1A 00	HLM1A N1F15 1	32	F S
E-0132	HLM1A BC BUFFER ENTRY 16A		H1A 00	HLM1A N1F16 1	32	F S
E-0133	HLM1A NON-BUFFERED BC COUNTER		H1A 00	HLM1A N1F17 1	16	F S
E-0134	HLM1A LAST UPLINK MESSAGE		H1A 00	HLM1A N1F17 3	16	F S
E-0135	HLM1A S/S FC COUNTER		H1A 00	HLM1A N1F18 1	16	F S
E-0136	HLM1A S/S BC COUNTER		H1A 00	HLM1A N1F18 3	16	F S
E-0137	HLM1A F/P FC COUNTER		H1A 00	HLM1A N1F19 1	16	F S
E-0138	HLM1A F/P BC COUNTER		H1A 00	HLM1A N1F19 3	16	F S
E-0139	UNASSIGNED				0	

Table A2.2.8. Engineering Measurements
CDS - COMMAND AND DATA SUBSYSTEM

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NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS	COMM POS	NO. OF BITS	FLAGS
E-0140	UNASSIGNED					
E-0141	HLM1A LLM BUS TRANSACTIONS RECEIVED		H1A 00	HLM1A N1F22 1	8	F S
E-0142	HLM1A DAC ERROR COUNTER		H1A 00	HLM1A N1F22 2	8	F S
E-0143	HLM1A MEM COPY/TWEAK ERROR COUNTER		H1A 00	HLM1A N1F22 3	8	F S
E-0144	HLM1A BUM ERROR LIMITER		H1A 00	HLM1A N1F22 4	8	F S
E-0145	HLM1A TO LLMS PRIVILEDGED FC COUNTER		H1A 00	HLM1A N1F23 1	8	F S
E-0146	HLM1A TO LLMS TOTAL FC COUNTER		H1A 00	HLM1A N1F23 2	8	F S
E-0147	HLM1A NON-PRIV CC/DC/POWER CODE COUNTER		H1A 00	HLM1A N1F23 3	8	F S
E-0148	HLM1A PRIV CC/DC/POWER CODE COUNTER		H1A 00	HLM1A N1F23 4	8	F S
E-0149	HLM1A SFP HGA POINTING DATA, BYTE 1		H1A 00	HLM1A N1F24 1	8	F S
E-0150	HLM1A SFP HGA POINTING DATA, BYTE 2		H1A 00	HLM1A N1F24 2	8	F S
E-0151	HLM1A SFP HGA POINTING DATA, BYTE 3		H1A 00	HLM1A N1F24 3	8	F S
E-0152	HLM1A SFP HGA POINTING DATA, BYTE 4		H1A 00	HLM1A N1F24 4	8	F S
E-0153	HLM1A DESPUN CRC REGISTERS 0-3		H1A 00	HLM1A N1F25 1	32	F S
E-0154	HLM1A DESPUN CRC REGISTERS 4-6		H1A 00	HLM1A N1F26 1	24	F S
E-0155	HLM1A DESPUN CRC BANK A		H1A 00	HLM1A N1F26 4	8	F S
E-0156	HLM1A SPUN CRC BANK A REGISTERS 0-3		H1A 00	HLM1A N1F27 1	32	F S
E-0157	HLM1A SPUN CRC BANK A REGISTERS 4-6		H1A 00	HLM1A N1F28 1	24	F S
E-0158	HLM1A SPUN CRC BANK A		H1A 00	HLM1A N1F28 4	8	F S
E-0159	HLM1A SPUN CRC BANK B REGISTERS 0-3		H1A 00	HLM1A N1F29 1	32	F S
E-0160	HLM1A SPUN CRC BANK B REGISTERS 4-7		H1A 00	HLM1A N1F30 1	32	F S
E-0161	HLM1A HCD COMMAND SUMMARY WORD		H1A 00	HLM1A N1F31 1	8	F S
E-0162	HLM1A MESSAGES RECEIVED AND ACCEPTED COUNTER		H1A 00	HLM1A N1F31 2	8	F S
E-0163	HLM1A MESSAGES RECEIVED AND REJECTED COUNTER		H1A 00	HLM1A N1F31 3	8	F S
E-0164	HLM1A COMMAND FRAME ERRORS DETECTED COUNTER		H1A 00	HLM1A N1F31 4	8	F S
E-0165	HLM1A DATA FRAME ERRORS CORRECTED COUNTER		H1A 00	HLM1A N1F32 1	8	F S

Table A2.2.8. Engineering Measurements
CDS - COMMAND AND DATA SUBSYSTEM

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS		COMM POS		NO. OF BITS	FLAGS	
E-0166	HLM1A DATA FRAME ERRORS UNCORRECTABLE COUNTER		H1A	00	HLM1A N1F32	2	8	F	S
E-0167	HLM1A LOCK CHANGES COUNTER		H1A	00	HLM1A N1F32	3	8	F	S
E-0168	HLM1A SPUM CRC STATUS WORD		H1A	00	HLM1A N1F32	4	8	F	S
E-0169	HLM1A ERROR WORDS IOSL 0-1-2		H1A	00	HLM1A N1F33	1	24	F	S
E-0170	HLM1A CMD LOSS RESPONSE COUNTER		H1A	00	HLM1A N1F33	4	8	F	S
E-0171	HLM1A BUM ERROR WORDS		H1A	00	HLM1A N1F34	1	32	F	S
E-0172	HLM1A DBUM ERROR WORDS		H1A	00	HLM1A N1F35	1	16	F	S
E-0173	HLM1A FLAG STATUS		H1A	00	HLM1A N1F35	3	8	F	S
E-0174	HLM1A EXTENDED BACKGROUND PROCESSING COUNTER		H1A	00	HLM1A N1F35	4	8	F	S
E-0175	HLM1A THIS CDS OF MODE		H1A	00	HLM1A N1F36	1	8	F	S
E-0176	HLM1A THIS SAFE REQUEST FLAG		H1A	00	HLM1A N1F36	2	8	F	S
E-0177	HLM1A THIS SAFE ENABLE		H1A	00	HLM1A N1F36	3	8	F	S
E-0178	HLM1A THIS EFFECTUAL DOWN FLAG		H1A	00	HLM1A N1F36	4	8	F	S
E-0179	HLM1A GPV-131 (SPARE TO OTHER HLM)		H1A	00	HLM1A N1F37	1	8	F	S
E-0180	HLM1A GPV-132 (SPARE TO OTHER HLM)		H1A	00	HLM1A N1F37	2	8	F	S
E-0181	HLM1A GPV-133 (SPARE TO OTHER HLM)		H1A	00	HLM1A N1F37	3	8	F	S
E-0182	HLM1A THIS SIDE LAUNCH MODE READY		H1A	00	HLM1A N1F37	4	8	F	S
E-0183	HLM1A OUT-OF-RANGE ALERT CODE COUNTER		H1A	00	HLM1A N1F38	1	8	F	S
E-0184	HLM1A ERRONEOUS ALERT CODE COUNTER		H1A	00	HLM1A N1F38	2	8	F	S
E-0185	HLM1A AACS ALERT CODE RECEIVED COUNTER		H1A	00	HLM1A N1F38	3	16	F	S
E-0186	HLM1A HEARTBEAT ENTRY COUNTER		H1A	00	HLM1A N1F39	1	8	F	S
E-0187	HLM1A HEARTBEAT ERROR COUNTER ACCUMULATED		H1A	00	HLM1A N1F39	2	8	F	S
E-0188	HLM1A LAST ALERT CODE		H1A	00	HLM1A N1F39	3	8	F	S
E-0189	HLM1A AACS ALERT CODE RESPONSE COUNTER		H1A	00	HLM1A N1F39	4	8	F	S
E-0190	HLM1A COMMAND LOSS RESPONSE START TIME		H1A	00	HLM1A N1F40	1	24	F	S
E-0191	HLM1A AACS HEARTBEAT CODE		H1A	00	HLM1A N1F40	4	8	F	S

Table A2.2.8. Engineering Measurements
CDS - COMMAND AND DATA SUBSYSTEM

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NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS	COMM POS	NO. OF BITS	FLAGS	
E-0192	HLM1A TF IMMINENT ALERT CODE COUNTER		H1A 00	HLM1A N1F41 1	8	F	S
E-0193	HLM1A TF ALL CLEAR ALERT CODE COUNTER		H1A 00	HLM1A N1F41 2	8	F	S
E-0194	HLM1A TF ALL CLEAR COMPLETION COUNTER		H1A 00	HLM1A N1F41 3	8	F	S
E-0195	HLM1A U/V RESPONSE COUNTER		H1A 00	HLM1A N1F41 4	8	F	S
E-0196	HLM1A S/C F/P MONITOR ENABLE (PRIV)		H1A 00	HLM1A N1F42 1	8	F	S
E-0197	HLM1A U/V DIODE UNSHORT COUNTER		H1A 00	HLM1A N1F42 2	8	F	S
E-0198	HLM1A OVERPRESSURE TEMPERATURE FLAG		H1A 00	HLM1A N1F42 3	8	F	S
E-0199	HLM1A U/V TRIP/INVERTER SWITCH COUNTER		H1A 00	HLM1A N1F42 4	8	F	S
E-0200	HLM1A S/C F/P RESPONSE ENABLES (PRIV)		H1A 00	HLM1A N1F43 1	24	F	S
E-0201	HLM1A CDS POR RESPONSE COUNTER		H1A 00	HLM1A N1F43 4	8	F	S
E-0202	HLM1A F/P CONDITION (REQUESTS) ENABLES		H1A 00	HLM1A N1F44 1	24	F	S
E-0203	HLM1A RFLOSS RESPONSE COUNTER		H1A 00	HLM1A N1F44 4	8	F	S
E-0204	HLM1A F/P RESPONSE INACTIVE ENABLES		H1A 00	HLM1A N1F45 1	24	F	S
E-0205	HLM1A PRIME/BACKUP STATUS		H1A 00	HLM1A N1F45 4	8	F	S
E-0206	HLM1A MOS F/P RESPONSE ENABLES (NON-PRIV)		H1A 00	HLM1A N1F46 1	24	F	S
E-0207	HLM1A AACS STATUS		H1A 00	HLM1A N1F46 4	8	F	S
E-0208	HLM1A MOS F/P MONITOR ENABLE (NON-PRIV)		H1A 00	HLM1A N1F47 1	8	F	S
E-0209	HLM1A MOS THRUSTER TEMPERATURE ENABLE (NON-PRIV)		H1A 00	HLM1A N1F47 2	8	F	S
E-0210	HLM1A CMD LOSS RESET DELTA RIMS		H1A 00	HLM1A N1F47 3	16	F	S
E-0211	HLM1A SYSTEM FAULT STATUS		H1A 00	HLM1A N1F48 2	16	F	S
E-0212	HLM1A F/P MODE		H1A 00	HLM1A N1F48 4	8	F	S
E-0213	HLM1A F/P PATH CONTROL		H1A 00	HLM1A N1F48 1	8	F	S
E-0214	HLM1A GV-92 (SPARE TO OTHER HLM)		H1A 00	HLM1A N1F20 1	8	F	S
E-0215	HLM1A GV-93 (SPARE TO OTHER HLM)		H1A 00	HLM1A N1F20 2	8	F	S
E-0216	HLM1A GV-94 (SPARE TO OTHER HLM)		H1A 00	HLM1A N1F20 3	8	F	S
E-0217	HLM1A GV-95 (SPARE TO OTHER HLM)		H1A 00	HLM1A N1F20 4	8	F	S

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Table A2.2.8. Engineering Measurements
CDS - COMMAND AND DATA SUBSYSTEM

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS	COMM POS	NO. OF BITS	FLAGS	
E-0218	HLM1A GV-96 (SPARE TO OTHER HLM)		H1A 00	HLM1A N1F21 1	8	F	S
E-0219	HLM1A GV-97 (SPARE TO OTHER HLM)		H1A 00	HLM1A N1F21 2	8	F	S
E-0220	HLM1A GV-98 (SPARE TO OTHER HLM)		H1A 00	HLM1A N1F21 3	8	F	S
E-0221	HLM1A GV-99 (SPARE TO OTHER HLM)		H1A 00	HLM1A N1F21 4	8	F	S
E-0222	HLM1A SYS DIAGNOSTIC MSG QUEUE ENTRY 1		H1A 00	HLM1A N1F49 1	16	F	S
E-0223	HLM1A SYS DIAGNOSTIC MSG QUEUE ENTRY 2		H1A 00	HLM1A N1F49 3	16	F	S
E-0224	HLM1A SYS DIAGNOSTIC MSG QUEUE ENTRY 3		H1A 00	HLM1A N1F50 1	16	F	S
E-0225	HLM1A SYS DIAGNOSTIC MSG QUEUE ENTRY 4		H1A 00	HLM1A N1F50 3	16	F	S
E-0226	HLM1A SYS DIAGNOSTIC MSG QUEUE ENTRY 5		H1A 00	HLM1A N1F51 1	16	F	S
E-0227	HLM1A SYS DIAGNOSTIC MSG QUEUE ENTRY 6		H1A 00	HLM1A N1F51 3	16	F	S
E-0228	HLM1A SYS DIAGNOSTIC MSG QUEUE ENTRY 7		H1A 00	HLM1A N1F52 1	16	F	S
E-0229	HLM1A SYS DIAGNOSTIC MSG QUEUE ENTRY 8		H1A 00	HLM1A N1F52 3	16	F	S
E-0230	HLM1A CDS DIAGNOSTIC MSG QUEUE ENTRY 1		H1A 00	HLM1A N1F53 1	16	F	S
E-0231	HLM1A CDS DIAGNOSTIC MSG QUEUE ENTRY 2		H1A 00	HLM1A N1F53 3	16	F	S
E-0232	HLM1A CDS DIAGNOSTIC MSG QUEUE ENTRY 3		H1A 00	HLM1A N1F54 1	16	F	S
E-0233	HLM1A CDS DIAGNOSTIC MSG QUEUE ENTRY 4		H1A 00	HLM1A N1F54 3	16	F	S
E-0234	HLM1A CDS DIAGNOSTIC MSG QUEUE ENTRY 5		H1A 00	HLM1A N1F55 1	16	F	S
E-0235	HLM1A CDS DIAGNOSTIC MSG QUEUE ENTRY 6		H1A 00	HLM1A N1F55 3	16	F	S
E-0236	HLM1A CDS DIAGNOSTIC MSG QUEUE ENTRY 7		H1A 00	HLM1A N1F56 1	16	F	S
E-0237	HLM1A CDS DIAGNOSTIC MSG QUEUE ENTRY 8		H1A 00	HLM1A N1F56 3	16	F	S
E-0238	HLM1A CAP/IAP PROGRAM STATE FILE		H1A 00	HLM1A N1F57 1	32	F	S
E-0239	HLM1A F/P PROGRAM STATE FILE ENTRY 1		H1A 00	HLM1A N1F58 1	32	F	S
E-0240	HLM1A F/P PROGRAM STATE FILE ENTRY 2		H1A 00	HLM1A N1F59 1	32	F	S
E-0241	HLM1A F/P PROGRAM STATE FILE ENTRY 3		H1A 00	HLM1A N1F60 1	32	F	S
E-0242	HLM1A F/P PROGRAM STATE FILE ENTRY 4		H1A 00	HLM1A N1F61 1	32	F	S
E-0243	HLM1A F/P PROGRAM STATE FILE ENTRY 5		H1A 00	HLM1A N1F62 1	32	F	S

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Table A2.2.8. Engineering Measurements
CDS - COMMAND AND DATA SUBSYSTEM

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS	COMM POS	NO. OF BITS	FLAGS
E-0244	HLM1A F/P PROGRAM STATE FILE ENTRY 6		H1A 00	HLM1A N1F63 1	32	F S
E-0245	HLM1A F/P PROGRAM STATE FILE ENTRY 7		H1A 00	HLM1A N1F64 1	32	F S
E-0246	HLM1A F/P PROGRAM STATE FILE ENTRY 8		H1A 00	HLM1A N1F65 1	32	F S
E-0247	HLM1A F/P PROGRAM STATE FILE ENTRY 9		H1A 00	HLM1A N1F66 1	32	F S
E-0248	HLM1A F/P PROGRAM STATE FILE ENTRY 10		H1A 00	HLM1A N1F67 1	32	F S
E-0249	HLM1A S/S PROGRAM STATE FILE ENTRY 1		H1A 00	HLM1A N1F68 1	32	F S
E-0250	HLM1A S/S PROGRAM STATE FILE ENTRY 2		H1A 00	HLM1A N1F69 1	32	F S
E-0251	HLM1A S/S PROGRAM STATE FILE ENTRY 3		H1A 00	HLM1A N1F70 1	32	F S
E-0252	HLM1A S/S PROGRAM STATE FILE ENTRY 4		H1A 00	HLM1A N1F71 1	32	F S
E-0253	HLM1A S/S PROGRAM STATE FILE ENTRY 5		H1A 00	HLM1A N1F72 1	32	F S
E-0254	HLM1A S/S PROGRAM STATE FILE ENTRY 6		H1A 00	HLM1A N1F73 1	32	F S
E-0255	HLM1A S/S PROGRAM STATE FILE ENTRY 7		H1A 00	HLM1A N1F74 1	32	F S
E-0256	HLM1A S/S PROGRAM STATE FILE ENTRY 8		H1A 00	HLM1A N1F75 1	32	F S
E-0257	HLM1A S/S PROGRAM STATE FILE ENTRY 9		H1A 00	HLM1A N1F76 1	32	F S
E-0258	HLM1A S/S PROGRAM STATE FILE ENTRY 10		H1A 00	HLM1A N1F77 1	32	F S
E-0259	HLM1A S/S PROGRAM STATE FILE ENTRY 11		H1A 00	HLM1A N1F78 1	32	F S
E-0260	HLM1A S/S PROGRAM STATE FILE ENTRY 12		H1A 00	HLM1A N1F79 1	32	F S
E-0261	HLM1A S/S PROGRAM STATE FILE ENTRY 13		H1A 00	HLM1A N1F80 1	32	F S
E-0262	HLM1A S/S PROGRAM STATE FILE ENTRY 14		H1A 00	HLM1A N1F81 1	32	F S
E-0263	HLM1A S/S PROGRAM STATE FILE ENTRY 15		H1A 00	HLM1A N1F82 1	32	F S
E-0264	HLM1A S/S PROGRAM STATE FILE ENTRY 16		H1A 00	HLM1A N1F83 1	32	F S
E-0265	HLM1A S/S PROGRAM STATE FILE ENTRY 17		H1A 00	HLM1A N1F84 1	32	F S
E-0266	HLM1A S/S PROGRAM STATE FILE ENTRY 18		H1A 00	HLM1A N1F85 1	32	F S
E-0267	HLM1A S/S PROGRAM STATE FILE ENTRY 19		H1A 00	HLM1A N1F86 1	32	F S
E-0268	HLM1A S/S PROGRAM STATE FILE ENTRY 20		H1A 00	HLM1A N1F87 1	32	F S
E-0269	HLM1A S/S PROGRAM STATE FILE ENTRY 21		H1A 00	HLM1A N1F88 1	32	F S

Table A2.2.8. Engineering Measurements
CDS - COMMAND AND DATA SUBSYSTEM

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS		COMM POS	NO. OF BITS	FLAGS	
E-0270	HLM1A S/S PROGRAM STATE FILE ENTRY 22		H1A	00	HLM1A N1F89 1	32	F	S
E-0271	HLM1A S/S PROGRAM STATE FILE ENTRY 23		H1A	00	HLM1A N1F90 1	32	F	S
E-0272	HLM1A BUFFER BC COUNTER		H1A	00	HLM1A N1S00 1	8	F	S
E-0273	HLM1A BC BUFFER ENTRY 1B		H1A	00	HLM1A N1S01 1	8	F	S
E-0274	HLM1A BC BUFFER ENTRY 2B		H1A	00	HLM1A N1S02 1	8	F	S
E-0275	HLM1A BC BUFFER ENTRY 3B		H1A	00	HLM1A N1S03 1	8	F	S
E-0276	HLM1A BC BUFFER ENTRY 4B		H1A	00	HLM1A N1S04 1	8	F	S
E-0277	HLM1A BC BUFFER ENTRY 5B		H1A	00	HLM1A N1S05 1	8	F	S
E-0278	HLM1A BC BUFFER ENTRY 6B		H1A	00	HLM1A N1S06 1	8	F	S
E-0279	HLM1A BC BUFFER ENTRY 7B		H1A	00	HLM1A N1S07 1	8	F	S
E-0280	HLM1A BC BUFFER ENTRY 8B		H1A	00	HLM1A N1S08 1	8	F	S
E-0281	HLM1A BC BUFFER ENTRY 9B		H1A	00	HLM1A N1S09 1	8	F	S
E-0282	HLM1A BC BUFFER ENTRY 10B		H1A	00	HLM1A N1S10 1	8	F	S
E-0283	HLM1A BC BUFFER ENTRY 11B		H1A	00	HLM1A N1S11 1	8	F	S
E-0284	HLM1A BC BUFFER ENTRY 12B		H1A	00	HLM1A N1S12 1	8	F	S
E-0285	HLM1A BC BUFFER ENTRY 13B		H1A	00	HLM1A N1S13 1	8	F	S
E-0286	HLM1A BC BUFFER ENTRY 14B		H1A	00	HLM1A N1S14 1	8	F	S
E-0287	HLM1A BC BUFFER ENTRY 15B		H1A	00	HLM1A N1S15 1	8	F	S
E-0288	HLM1A BC BUFFER ENTRY 16B		H1A	00	HLM1A N1S16 1	8	F	S
E-0289	HLM1A CAP FC COUNTER		H1A	00	HLM1A N1S17 1	8	F	S
E-0290	HLM1A CAP BC COUNTER		H1A	00	HLM1A N1S18 1	8	F	S
E-0291	HLM1A IAP FC COUNTER		H1A	00	HLM1A N1S19 1	8	F	S
E-0292	HLM1A IAP BC COUNTER		H1A	00	HLM1A N1S20 1	8	F	S
E-0293	HLM1A SFP PROTECTED PATH CONTROL		H1A	00	HLM1A N1S21 1	8	F	S
E-0294	HLM1A SPARE		H1A	00	HLM1A N1S22 1	8	F	S
E-0295	HLM1A SPARE		H1A	00	HLM1A N1S23 1	8	F	S

Table A2.2.8. Engineering Measurements
CDS - COMMAND AND DATA SUBSYSTEM

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS	COMM POS	NO. OF BITS	FLAGS
E-0296	HLM1A SPARE		H1A 00	HLM1A N1S24 1	8	F S
E-0297	HLM1A UPLINK IAP COUNTER		H1A 00	HLM1A N1S25 1	8	F S
E-0298	HLM1A UPLINK DAC COUNTER		H1A 00	HLM1A N1S26 1	8	F S
E-0299	HLM1A UPLINK NML COUNTER		H1A 00	HLM1A N1S27 1	8	F S
E-0300	HLM1A UPLINK IEX COUNTER		H1A 00	HLM1A N1S28 1	8	F S
E-0301	HLM1A UPLINK MSD(P) COUNTER		H1A 00	HLM1A N1S29 1	8	F S
E-0302	HLM1A UPLINK MSD(T) COUNTER		H1A 00	HLM1A N1S30 1	8	F S
E-0303	HLM1A UPLINK NMSL COUNTER		H1A 00	HLM1A N1S31 1	8	F S
E-0304	HLM1A UPLINK PMSL COUNTER		H1A 00	HLM1A N1S32 1	8	F S
E-0305	HLM1A UPLINK CAP COUNTER		H1A 00	HLM1A N1S33 1	8	F S
E-0306	HLM1A UPLINK NML/NMSL ERROR COUNTER		H1A 00	HLM1A N1S34 1	8	F S
E-0307	HLM1A UPLINK MSL ERROR COUNTER		H1A 00	HLM1A N1S35 1	8	F S
E-0308	HLM1A SPARE		H1A 00	HLM1A N1S36 1	8	F S
E-0309	HLM1A SPARE		H1A 00	HLM1A N1S37 1	8	F S
E-0310	HLM1A SPARE		H1A 00	HLM1A N1S38 1	8	F S
E-0311	HLM1A SPARE		H1A 00	HLM1A N1S39 1	8	F S
E-0312	HLM1A SPARE		H1A 00	HLM1A N1S40 1	8	F S
E-0313	HLM1A SPARE		H1A 00	HLM1A N1S41 1	8	F S
E-0314	HLM1A SPARE		H1A 00	HLM1A N1S42 1	8	F S
E-0315	HLM1A SPARE		H1A 00	HLM1A N1S43 1	8	F S
E-0316	HLM1A SPARE		H1A 00	HLM1A N1S44 1	8	F S
E-0317	HLM1A SPARE		H1A 00	HLM1A N1S45 1	8	F S
E-0318	HLM1A SPARE		H1A 00	HLM1A N1S46 1	8	F S
E-0319	HLM1A SPARE		H1A 00	HLM1A N1S47 1	8	F S
E-0320	HLM1A SPARE		H1A 00	HLM1A N1S48 1	8	F S
E-0321	HLM1A SYSTEM DIAGNOSTIC MESSAGE COUNTER		H1A 00	HLM1A N1S49 1	8	F S

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Table A2.2.8. Engineering Measurements
CDS - COMMAND AND DATA SUBSYSTEM

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS		COMM POS		NO. OF BITS	FLAGS	
E-0322	HLM1A CDS DIAGNOSTIC MESSAGE COUNTER		H1A	00	HLM1A N1S50	1	8	F	S
E-0323	HLM1A MARK FC COUNTER		H1A	00	HLM1A N1S51	1	8	F	S
E-0324	HLM1A S/C THRUSTER TEMPERATURE ENABLE (PRIV)		H1A	00	HLM1A N1S52	1	8	F	S
E-0325	HLM1A CAP START LINK		H1A	00	HLM1A N1S53	1	8	F	S
E-0326	HLM1A F/P START LINK		H1A	00	HLM1A N1S54	1	8	F	S
E-0327	HLM1A IAP START LINK		H1A	00	HLM1A N1S55	1	8	F	S
E-0328	HLM1A S/S START LINK		H1A	00	HLM1A N1S56	1	8	F	S
E-0329	HLM1A UPLINK NMSL/PMSL SEQUENCE NUMBER		H1A	00	HLM1A N1S57	1	8	F	S
E-0330	HLM1A UPLINK CHECKSTATE		H1A	00	HLM1A N1S58	1	8	F	S
E-0331	HLM1A MISSING MESSAGE LIST 1		H1A	00	HLM1A N1S59	1	8	F	S
E-0332	HLM1A MISSING MESSAGE LIST 2		H1A	00	HLM1A N1S60	1	8	F	S
E-0333	HLM1A MISSING MESSAGE LIST 3		H1A	00	HLM1A N1S61	1	8	F	S
E-0334	HLM1A MISSING MESSAGE LIST 4		H1A	00	HLM1A N1S62	1	8	F	S
E-0335	HLM1A MISSING MESSAGE LIST 5		H1A	00	HLM1A N1S63	1	8	F	S
E-0336	HLM1A MISSING MESSAGE LIST 6		H1A	00	HLM1A N1S64	1	8	F	S
E-0337	HLM1A MISSING MESSAGE LIST 7		H1A	00	HLM1A N1S65	1	8	F	S
E-0338	HLM1A MISSING MESSAGE LIST 8		H1A	00	HLM1A N1S66	1	8	F	S
E-0339	HLM1A MISSING MESSAGE LIST 9		H1A	00	HLM1A N1S67	1	8	F	S
E-0340	HLM1A MISSING MESSAGE LIST 10		H1A	00	HLM1A N1S68	1	8	F	S
E-0341	HLM1A MISSING MESSAGE LIST 11		H1A	00	HLM1A N1S69	1	8	F	S
E-0342	HLM1A MISSING MESSAGE LIST 12		H1A	00	HLM1A N1S70	1	8	F	S
E-0343	HLM1A MISSING MESSAGE LIST 13		H1A	00	HLM1A N1S71	1	8	F	S
E-0344	HLM1A MISSING MESSAGE LIST 14		H1A	00	HLM1A N1S72	1	8	F	S
E-0345	HLM1A MISSING MESSAGE LIST 15		H1A	00	HLM1A N1S73	1	8	F	S
E-0346	HLM1A MISSING MESSAGE LIST 16		H1A	00	HLM1A N1S74	1	8	F	S
E-0347	HLM1A MISSING MESSAGE LIST 17		H1A	00	HLM1A N1S75	1	8	F	S

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Table A2.2.8. Engineering Measurements
CDS - COMMAND AND DATA SUBSYSTEM

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS	COMM POS	NO. OF BITS	FLAGS
E-0348	HLM1A MISSING MESSAGE LIST 18		H1A 00	HLM1A N1S76 1	8	F S
E-0349	HLM1A MISSING MESSAGE LIST 19		H1A 00	HLM1A N1S77 1	8	F S
E-0350	HLM1A MISSING MESSAGE LIST 20		H1A 00	HLM1A N1S78 1	8	F S
E-0351	HLM1A MISSING MESSAGE LIST 21		H1A 00	HLM1A N1S79 1	8	F S
E-0352	HLM1A MISSING MESSAGE LIST 22		H1A 00	HLM1A N1S80 1	8	F S
E-0353	HLM1A MISSING MESSAGE LIST 23		H1A 00	HLM1A N1S81 1	8	F S
E-0354	HLM1A MISSING MESSAGE LIST 24		H1A 00	HLM1A N1S82 1	8	F S
E-0355	HLM1A MISSING MESSAGE LIST 25		H1A 00	HLM1A N1S83 1	8	F S
E-0356	HLM1A MISSING MESSAGE LIST 26		H1A 00	HLM1A N1S84 1	8	F S
E-0357	HLM1A MISSING MESSAGE LIST 27		H1A 00	HLM1A N1S85 1	8	F S
E-0358	HLM1A MISSING MESSAGE LIST 28		H1A 00	HLM1A N1S86 1	8	F S
E-0359	HLM1A MISSING MESSAGE LIST 29		H1A 00	HLM1A N1S87 1	8	F S
E-0360	HLM1A MISSING MESSAGE LIST 30		H1A 00	HLM1A N1S88 1	8	F S
E-0361	HLM1A MISSING MESSAGE LIST 31		H1A 00	HLM1A N1S89 1	8	F S
E-0362	HLM1A MISSING MESSAGE LIST 32		H1A 00	HLM1A N1S90 1	8	F S
E-0365	LLM1A DMS FCS EXECUTED COUNTER		L1A 94	LLM1A N1D28 1	8	F S
E-0366	LLM1A DMS FCS REJECTED COUNTER		L1A 95	LLM1A N1D28 2	8	F S
E-0367	LLM1A DMS CMDS SENT COUNTER		L1A 96	LLM1A N1D29 1	8	F S
E-0368	LLM1A LAST DMS COMMAND SENT		L1A 97	LLM1A N1D29 2	8	F S
E-0369	LLM1A EPD/PLS ENABLE STATUS		L1A 98	LLM1A N1D30 1	8	F S
E-0370	LLM1A LAST CC/DC RIM COUNT MSB/ISB		L1A 80	LLM1A N1D08 1	16	F S
E-0370			L1A 81			
E-0371	LLM1A LAST CC/DC RIM COUNT LSB		L1A 82	LLM1A N1D09 1	8	F S
E-0372	LLM1A LAST CC/DC MOD91		L1A 83	LLM1A N1D09 2	8	F S
E-0373	LLM1A LAST CC/DC MOD10		L1A 84	LLM1A N1D10 1	8	F S
E-0374	LLM1A LAST CC/DC POINTER		L1A 85	LLM1A N1D10 2	8	F S

Table A2.2.8. Engineering Measurements
CDS - COMMAND AND DATA SUBSYSTEM

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS	COMM POS	NO. OF BITS	FLAGS
E-0375	LLM1A CC/DC BUFFER ENTRY 1		L1A 86	LLM1A N1D11 1	16	F S
E-0375			L1A 87			
E-0376	LLM1A CC/DC BUFFER ENTRY 2		L1A 88	LLM1A N1D12 1	16	F S
E-0376			L1A 89			
E-0377	LLM1A CC/DC BUFFER ENTRY 3		L1A 8A	LLM1A N1D21 1	16	F S
E-0377			L1A 8B			
E-0378	LLM1A CC/DC BUFFER ENTRY 4		L1A 8C	LLM1A N1D22 1	16	F S
E-0378			L1A 8D			
E-0379	LLM1A CC/DC BUFFER ENTRY 5		L1A 8E	LLM1A N1D23 1	16	F S
E-0379			L1A 8F			
E-0380	LLM1A CC/DC BUFFER ENTRY 6		L1A 90	LLM1A N1D24 1	16	F S
E-0380			L1A 91			
E-0381	LLM1A CC/DC BUFFER ENTRY 7		L1A 92	LLM1A N1D25 1	16	F S
E-0381			L1A 93			
E-0382	LLM1A PRIV CC/DC EXECUTED COUNTER		L1A 9E	LLM1A N1D34 1	8	F S
E-0383	LLM1A NON-PRIV CC/DC EXECUTED COUNTER		L1A 9F	LLM1A N1D34 2	8	F S
E-0384	LLM1A PRIV CC/DC/(POWER CODE) QUEUED COUNTER		L1A A0	LLM1A N1D35 1	8	F S
E-0385	LLM1A NON-PRIV CC/DC/(POWER CODE) QUEUED COUNTER		L1A A1	LLM1A N1D35 2	8	F S
E-0386	LLM1A TEMPERATURE CC/DC QUEUED COUNTER		L1A A2	LLM1A N1D36 1	8	F S
E-0387	LLM1A DAC CC/DC QUEUED COUNTER		L1A A3	LLM1A N1D36 2	8	F S
E-0388	LLM1A AACS POWER CODES QUEUED COUNTER		L1A A4	LLM1A N1D37 1	8	F S
E-0389	LLM1A AACS POWER CODES REJECTED COUNTER		L1A A5	LLM1A N1D37 2	8	F S
E-0390	LLM1A EPF/PLS CC/DC'S QUEUED COUNTER		L1A A6	LLM1A N1D38 1	8	F S
E-0391	LLM1A LAST VALID AACS POWER CODE		L1A A7	LLM1A N1D38 2	8	F S
E-0392	LLM1A FC'S RECEIVED COUNTER		L1A A8	LLM1A N1D47 1	8	F S
E-0393	LLM1A FC'S EXECUTED COUNTER		L1A A9	LLM1A N1D47 2	8	F S

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Table A2.2.8. Engineering Measurements
CDS - COMMAND AND DATA SUBSYSTEM

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS	COMM POS	NO. OF BITS	FLAGS
E-0394	LLM1A LAST VALID FC ID		L1A AA	LLM1A N1D48 1	8	F S
E-0395	LLM1A FC'S REJECTED COUNTER		L1A AB	LLM1A N1D48 2	8	F S
E-0396	LLM1A CHANGE PACKET SELECTION COUNTER		L1A AC	LLM1A N1D49 1	8	F S
E-0397	LLM1A BUS TRANSACTIONS SENT COUNTER		L1A AD	LLM1A N1D49 2	8	F S
E-0398	LLM1A CHANGE PACKET TIMING COUNTER		L1A AE	LLM1A N1D50 1	8	F S
E-0399	LLM1A UPDATE PACKET MENU COUNTER		L1A AF	LLM1A N1D50 2	8	F S
E-0400	LLM1A AACS POWER CODES RECEIVED COUNTER		L1A B0	LLM1A N1D51 1	16	F S
E-0400			L1A B1			
E-0401	LLM1A FLAG STATUS		L1A B6	LLM1A N1D60 1	8	F S
E-0402	LLM1A CDS DIAGNOSTIC MESSAGE COUNTER		L1A B7	LLM1A N1D60 2	8	F S
E-0403	LLM1A CDS DIAGNOSTIC MSG QUEUE ENTRY 1		L1A B8	LLM1A N1D61 1	16	F S
E-0403			L1A B9			
E-0404	LLM1A CDS DIAGNOSTIC MSG QUEUE ENTRY 2		L1A BA	LLM1A N1D62 1	16	F S
E-0404			L1A BB			
E-0405	LLM1A CDS DIAGNOSTIC MSG QUEUE ENTRY 3		L1A BC	LLM1A N1D63 1	16	F S
E-0405			L1A BD			
E-0406	LLM1A CDS DIAGNOSTIC MSG QUEUE ENTRY 4		L1A BE	LLM1A N1D64 1	16	F S
E-0406			L1A BF			
E-0407	LLM1A SPARE		L1A C0	LLM1A N1D73 1	8	F S
E-0408	LLM1A SYS DIAGNOSTIC MESSAGE COUNTER		L1A C1	LLM1A N1D73 2	8	F S
E-0409	LLM1A SYS DIAGNOSTIC MSG QUEUE ENTRY 1		L1A C2	LLM1A N1D74 1	16	F S
E-0409			L1A C3			
E-0410	LLM1A SYS DIAGNOSTIC MSG QUEUE ENTRY 2		L1A C4	LLM1A N1D75 1	16	F S
E-0410			L1A C5			
E-0411	LLM1A SYS DIAGNOSTIC MSG QUEUE ENTRY 3		L1A C6	LLM1A N1D76 1	16	F S
E-0411			L1A C7			

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Table A2.2.8. Engineering Measurements
CDS - COMMAND AND DATA SUBSYSTEM

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS	COMM POS	NO. OF BITS	FLAGS
E-0412	LLM1A SYS DIAGNOSTIC MSG QUEUE ENTRY 4		L1A C8	LLM1A N1D77 1	16	F S
E-0412			L1A C9			
E-0413	LLM1A ERROR WORD-1 IOSL-0		L1A CE	LLM1A N1D86 1	8	F S
E-0414	LLM1A ERROR WORD-2 IOSL-1		L1A CF	LLM1A N1D86 2	8	F S
E-0415	LLM1A DAC MAP PART-1		L1A D0	LLM1A N1D87 1	16	F S
E-0415			L1A D1			
E-0416	LLM1A DAC MAP PART-2		L1A D2	LLM1A N1D88 1	16	F S
E-0416			L1A D3			
E-0417	LLM1A DACS RECEIVED COUNTER		L1A D4	LLM1A N1D89 1	8	F S
E-0418	LLM1A DACS REJECTED COUNTER		L1A D5	LLM1A N1D89 2	8	F S
E-0419	LLM1A DAC BC COUNTER		L1A D6	LLM1A N1D90 1	8	F S
E-0420	LLM1A DAC CHECKSUM ERROR COUNTER		L1A D7	LLM1A N1D90 2	8	F S
E-0421	LLM1A S/C TEMPERATURE ENABLE STATUS (PRIV)		L1A B4	LLM1A N1D55 1	8	F S
E-0422	LLM1A MOS TEMPERATURE ENABLE STATUS (NON-PRIV)		L1A B5	LLM1A N1D55 2	8	F S
E-0423	LLM1A DMS TAPE POSITION ESTIMATE MSB		L1A FD	LLM1A T1S00 1	8	F S
E-0424	LLM1A DMS TAPE POSITION ESTIMATE LSB		L1A FE	LLM1A T2S00 1	8	F S
E-0425	LLM1A MEMORY COPY FC COUNTER		L1A 99	LLM1A N1D30 2	8	F S
E-0426	LLM1A TEMPERATURE BC COUNTER		L1A 9A	LLM1A N1D31 1	8	F S
E-0427	LLM1A MEMORY TWEAK FC COUNTER		L1A 9B	LLM1A N1D31 2	8	F S
E-0428	LLM1A CHECKSUM RESULT		L1A 9C	LLM1A N1D32 1	8	F S
E-0429	LLM1A CHECKSUM COUNTER		L1A 9D	LLM1A N1D32 2	8	F S
E-0430	LLM2A LAST CC/DC RIM COUNT MSB/ISB		L2A 80	LLM2A N1D08 1	16	F S
E-0430			L2A 81			
E-0431	LLM2A LAST CC/DC RIM COUNT LSB		L2A 82	LLM2A N1D09 1	8	F S
E-0432	LLM2A LAST CC/DC MOD91		L2A 83	LLM2A N1D09 2	8	F S
E-0433	LLM2A LAST CC/DC MOD10		L2A 84	LLM2A N1D10 1	8	F S

Table A2.2.8. Engineering Measurements
CDS - COMMAND AND DATA SUBSYSTEM

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS	COMM POS	NO. OF BITS	FLAGS
E-0434	LLM2A LAST CC/DC POINTER		L2A 85	LLM2A N1D10 2	8	F S
E-0435	LLM2A LAST CC/DC BUFFER ENTRY 1		L2A 86	LLM2A N1D11 1	16	F S
E-0435			L2A 87			
E-0436	LLM2A LAST CC/DC BUFFER ENTRY 2		L2A 88	LLM2A N1D12 1	16	F S
E-0436			L2A 89			
E-0437	LLM2A LAST CC/DC BUFFER ENTRY 3		L2A 8A	LLM2A N1D21 1	16	F S
E-0437			L2A 8B			
E-0438	LLM2A LAST CC/DC BUFFER ENTRY 4		L2A 8C	LLM2A N1D22 1	16	F S
E-0438			L2A 8D			
E-0439	LLM2A LAST CC/DC BUFFER ENTRY 5		L2A 8E	LLM2A N1D23 1	16	F S
E-0439			L2A 8F			
E-0440	LLM2A LAST CC/DC BUFFER ENTRY 6		L2A 90	LLM2A N1D24 1	16	F S
E-0440			L2A 91			
E-0441	LLM2A LAST CC/DC BUFFER ENTRY 7		L2A 92	LLM2A N1D25 1	16	F S
E-0441			L2A 93			
E-0442	LLM2A PRIV CC/DC EXECUTED COUNTER		L2A 9E	LLM2A N1D34 1	8	F S
E-0443	LLM2A MON-PRIV CC/DC EXECUTED COUNTER		L2A 9F	LLM2A N1D34 2	8	F S
E-0444	LLM2A CC/DC/(POWER CODE) QUEUED COUNTER		L2A A0	LLM2A N1D35 1	8	F S
E-0445	LLM2A NON-PRIV CC/DC/(POWER CODE) QUEUED COUNTER		L2A A1	LLM2A N1D35 2	8	F S
E-0446	LLM2A TEMPERATURE CC/DC QUEUED COUNTER		L2A A2	LLM2A N1D36 1	8	F S
E-0447	LLM2A DAC CC/DC QUEUED COUNTER		L2A A3	LLM2A N1D36 2	8	F S
E-0448	LLM2A AACS POWER CODES QUEUED COUNTER		L2A A4	LLM2A N1D37 1	8	F S
E-0449	LLM2A AACS POWER CODES REJECTED COUNTER		L2A A5	LLM2A N1D37 2	8	F S
E-0450	LLM2A EPD/PLS CC/DC QUEUED COUNTER (DUMMY)		L2A A6	LLM2A N1D38 1	8	F S
E-0451	LLM2A LAST VALID AACS POWER CODE		L2A A7	LLM2A N1D38 2	8	F S
E-0452	LLM2A FC'S RECEIVED COUNTER		L2A A8	LLM2A N1D47 1	8	F S

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Table A2.2.8. Engineering Measurements
CDS - COMMAND AND DATA SUBSYSTEM

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS	COMM POS	NO. OF BITS	FLAGS
E-0453	LLM2A FC'S EXECUTED COUNTER		L2A A9	LLM2A N1D47 2	8	F S
E-0454	LLM2A LAST VALID FC ID		L2A AA	LLM2A N1D48 1	8	F S
E-0455	LLM2A FC'S REJECTED COUNTER		L2A AB	LLM2A N1D48 2	8	F S
E-0456	LLM2A CHANGE PACKET SELECTION COUNTER		L2A AC	LLM2A N1D49 1	8	F S
E-0457	LLM2A BUS TRANSACTIONS SENT COUNTER (DUMMY)		L2A AD	LLM2A N1D49 2	8	F S
E-0458	LLM2A CHANGE PACKET TIMING COUNTER		L2A AE	LLM2A N1D50 1	8	F S
E-0459	LLM2A UPDATE PACKET MENU COUNTER		L2A AF	LLM2A N1D50 2	8	F S
E-0460	LLM2A AACS POWER CODES RECEIVED COUNTER		L2A B0	LLM2A N1D51 1	16	F S
E-0460			L2A B1			
E-0461	LLM2A FLAG STATUS		L2A B6	LLM2A N1D60 1	8	F S
E-0462	LLM2A CDS DIAGNOSTIC MESSAGE COUNTER		L2A B7	LLM2A N1D60 2	8	F S
E-0463	LLM2A CDS DIAGNOSTIC MSG QUEUE ENTRY 1		L2A B8	LLM2A N1D61 1	16	F S
E-0463			L2A B9			
E-0464	LLM2A CDS DIAGNOSTIC MSG QUEUE ENTRY 2		L2A BA	LLM2A N1D62 1	16	F S
E-0464			L2A BB			
E-0465	LLM2A CDS DIAGNOSTIC MSG QUEUE ENTRY 3		L2A BC	LLM2A N1D63 1	16	F S
E-0465			L2A BD			
E-0466	LLM2A CDS DIAGNOSTIC MSG QUEUE ENTRY 4		L2A BE	LLM2A N1D64 1	16	F S
E-0466			L2A BF			
E-0467	LLM2A SPARE		L2A C0	LLM2A N1D73 1	8	F S
E-0468	LLM2A SYSTEM DIAGNOSTIC MESSAGE COUNTER		L2A C1	LLM2A N1D73 2	8	F S
E-0469	LLM2A SYS DIAGNOSTIC MSG QUEUE ENTRY 1		L2A C2	LLM2A N1D74 1	16	F S
E-0469			L2A C3			
E-0470	LLM2A SYS DIAGNOSTIC MSG QUEUE ENTRY 2		L2A C4	LLM2A N1D75 1	16	F S
E-0470			L2A C5			
E-0471	LLM2A SYS DIAGNOSTIC MSG QUEUE ENTRY 3		L2A C6	LLM2A N1D76 1	16	F S
E-0471			L2A C7			

Table A2.2.8. Engineering Measurements
CDS - COMMAND AND DATA SUBSYSTEM

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NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS	COMM POS	NO. OF BITS	FLAGS	
E-0472	LLM2A SYS DIAGNOSTIC MSG QUEUE ENTRY 4		L2A C8	LLM2A N1D77 1	16	F	S
E-0472			L2A C9		0		
E-0473	LLM2A ERROR WORD-1 IOSL-0		L2A CE	LLM2A N1D86 1	8	F	S
E-0474	LLM2A ERROR WORD-2 IOSL-1		L2A CF	LLM2A N1D86 2	8	F	S
E-0475	LLM2A DAC MAP PART-1		L2A D0	LLM2A N1D87 1	16	F	S
E-0475			L2A D1		0		
E-0476	LLM2A DAC MAP PART-2		L2A D2	LLM2A N1D88 1	16	F	S
E-0476			L2A D3		0		
E-0477	LLM2A DACS RECEIVED COUNTER		L2A D4	LLM2A N1D89 1	8	F	S
E-0478	LLM2A DACS REJECTED COUNTER		L2A D5	LLM2A N1D89 2	8	F	S
E-0479	LLM2A DAC BC COUNTER (DUMMY)		L2A D6	LLM2A N1D90 1	8	F	S
E-0480	LLM2A DAC CHECKSUM ERROR COUNTER		L2A D7	LLM2A N1D90 2	8	F	S
E-0481	LLM2A S/C TEMPERATURE ENABLE STATUS (PRIV)		L2A B4	LLM2A N1D55 1	8	F	S
E-0482	LLM2A MOS TEMPERATURE ENABLE STATUS (MON-PRIV)		L2A B5	LLM2A N1D55 2	8	F	S
E-0615	HLM1B LAST BC RIM COUNT		H1B 00	HLM1B N1F00 1	24	F	S
E-0616	HLM1B LAST BC MOD91		H1B 00	HLM1B N1F00 4	8	F	S
E-0617	HLM1B BC BUFFER ENTRY 1A		H1B 00	HLM1B N1F01 1	32	F	S
E-0618	HLM1B BC BUFFER ENTRY 2A		H1B 00	HLM1B N1F02 1	32	F	S
E-0619	HLM1B BC BUFFER ENTRY 3A		H1B 00	HLM1B N1F03 1	32	F	S
E-0620	HLM1B BC BUFFER ENTRY 4A		H1B 00	HLM1B N1F04 1	32	F	S
E-0621	HLM1B BC BUFFER ENTRY 5A		H1B 00	HLM1B N1F05 1	32	F	S
E-0622	HLM1B BC BUFFER ENTRY 6A		H1B 00	HLM1B N1F06 1	32	F	S
E-0623	HLM1B BC BUFFER ENTRY 7A		H1B 00	HLM1B N1F07 1	32	F	S
E-0624	HLM1B BC BUFFER ENTRY 8A		H1B 00	HLM1B N1F08 1	32	F	S
E-0625	HLM1B BC BUFFER ENTRY 9A		H1B 00	HLM1B N1F09 1	32	F	S

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS		COMM POS		NO. OF	FLAGS	
E-0626	HLM1B BC BUFFER ENTRY 10A		H1B	00	HLM1B N1F10	1	32	F	S
E-0627	HLM1B BC BUFFER ENTRY 11A		H1B	00	HLM1B N1F11	1	32	F	S
E-0628	HLM1B BC BUFFER ENTRY 12A		H1B	00	HLM1B N1F12	1	32	F	S
E-0629	HLM1B BC BUFFER ENTRY 13A		H1B	00	HLM1B N1F13	1	32	F	S
E-0630	HLM1B BC BUFFER ENTRY 14A		H1B	00	HLM1B N1F14	1	32	F	S
E-0631	HLM1B BC BUFFER ENTRY 15A		H1B	00	HLM1B N1F15	1	32	F	S
E-0632	HLM1B BC BUFFER ENTRY 16A		H1B	00	HLM1B N1F16	1	32	F	S
E-0633	HLM1B NON-BUFFER BC COUNTER		H1B	00	HLM1B N1F17	1	16	F	S
E-0634	HLM1B LAST UPLINK MESSAGE		H1B	00	HLM1B N1F17	3	16	F	S
E-0635	HLM1B S/S FC COUNTER		H1B	00	HLM1B N1F18	1	16	F	S
E-0636	HLM1B S/S BC COUNTER		H1B	00	HLM1B N1F18	3	16	F	S
E-0637	HLM1B F/P FC COUNTER		H1B	00	HLM1B N1F19	1	16	F	S
E-0638	HLM1B F/P BC COUNTER		H1B	00	HLM1B N1F19	3	16	F	S
E-0639	UNASSIGNED						0		
E-0640	UNASSIGNED						0		
E-0641	HLM1B LLM BUS TRANSACTIONS RECEIVED		H1B	00	HLM1B N1F22	1	8	F	S
E-0642	HLM1B DAC ERROR COUNTER		H1B	00	HLM1B N1F22	2	8	F	S
E-0643	HLM1B MEM COPY/TWEAK ERROR COUNTER		H1B	00	HLM1B N1F22	3	8	F	S
E-0644	HLM1B BUM ERROR LIMITER		H1B	00	HLM1B N1F22	4	8	F	S
E-0645	HLM1B TO LLMS PRIVILEDGED FC COUNTER		H1B	00	HLM1B N1F23	1	8	F	S
E-0646	HLM1B TO LLMS TOTAL FC COUNTER		H1B	00	HLM1B N1F23	2	8	F	S
E-0647	HLM1B NON-PRIV CC/DC/POWER CODE COUNTER		H1B	00	HLM1B N1F23	3	8	F	S
E-0648	HLM1B PRIV CC/DC/POWER CODE COUNTER		H1B	00	HLM1B N1F23	4	8	F	S
E-0649	HLM1B GPV-28 (SPARE)		H1B	00	HLM1B N1F24	1	8	F	S
E-0650	HLM1B GPV-29 (SPARE)		H1B	00	HLM1B N1F24	2	8	F	S
E-0651	HLM1B GPV-30 (SPARE)		H1B	00	HLM1B N1F24	3	8	F	S

Table A2.2.8. Engineering Measurements
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NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS	COMM POS	NO. OF BITS	FLAGS
E-0652	HLM1B SFP HGA POINTING DATA, BYTE 4		H1B 00	HLM1B N1F24 4	8	F S
E-0653	HLM1B DESPUN CRC REGISTERS 0-3		H1B 00	HLM1B N1F25 1	32	F S
E-0654	HLM1B DESPUN CRC REGISTERS 4-6		H1B 00	HLM1B N1F26 1	24	F S
E-0655	HLM1B DESPUN CRC BANK B		H1B 00	HLM1B N1F26 4	8	F S
E-0656	HLM1B SPUN CRC BANK A REGISTERS 0-3		H1B 00	HLM1B N1F27 1	32	F S
E-0657	HLM1B SPUN CRC BANK A REGISTERS 4-6		H1B 00	HLM1B N1F28 1	24	F S
E-0658	HLM1B SPUN CRC BANK B		H1B 00	HLM1B N1F28 4	8	F S
E-0659	HLM1B SPUN CRC BANK B REGISTERS 0-3		H1B 00	HLM1B N1F29 1	32	F S
E-0660	HLM1B SPUN CRC BANK B REGISTERS 4-7		H1B 00	HLM1B N1F30 1	32	F S
E-0661	HLM1B HCD COMMAND SUMMARY WORD		H1B 00	HLM1B N1F31 1	8	F S
E-0662	HLM1B MESSAGES RECEIVED AND ACCEPTED COUNTER		H1B 00	HLM1B N1F31 2	8	F S
E-0663	HLM1B MESSAGES RECEIVED AND REJECTED COUNTER		H1B 00	HLM1B N1F31 3	8	F S
E-0664	HLM1B COMMAND FRAME ERRORS DETECTED COUNTER		H1B 00	HLM1B N1F31 4	8	F S
E-0665	HLM1B DATA FRAME ERRORS CORRECTED COUNTER		H1B 00	HLM1B N1F32 1	8	F S
E-0666	HLM1B DATA FRAME ERRORS UNCORRECTABLE COUNTER		H1B 00	HLM1B N1F32 2	8	F S
E-0667	HLM1B LOCK CHANGES COUNTER		H1B 00	HLM1B N1F32 3	8	F S
E-0668	HLM1B SPUN CRC STATUS WORD		H1B 00	HLM1B N1F32 4	8	F S
E-0669	HLM1B ERROR WORDS IOSL 0-1-2		H1B 00	HLM1B N1F33 1	24	F S
E-0670	HLM1B CMD LOSS RESPONSE COUNTER		H1B 00	HLM1B N1F33 4	8	F S
E-0671	HLM1B BUM ERROR WORDS		H1B 00	HLM1B N1F34 1	32	F S
E-0672	HLM1B DBUM ERROR WORDS		H1B 00	HLM1B N1F35 1	16	F S
E-0673	HLM1B FLAG STATUS		H1B 00	HLM1B N1F35 3	8	F S
E-0674	HLM1B EXTENDED BACKGROUND PROCESSING COUNTER		H1B 00	HLM1B N1F35 4	8	F S
E-0675	HLM1B THIS CDS OP MODE		H1B 00	HLM1B N1F36 1	8	F S
E-0676	HLM1B THIS SAFE REQUEST FLAG		H1B 00	HLM1B N1F36 2	8	F S
E-0677	HLM1B THIS SAFE ENABLE		H1B 00	HLM1B N1F36 3	8	F S

Table A2.2.8. Engineering Measurements
CDS - COMMAND AND DATA SUBSYSTEM

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS		COMM POS		NO. OF BITS	FLAGS	
E-0678	HLM1B THIS EFFECTUAL DOWN FLAG		H1B	00	HLM1B N1F36	4	8	F	S
E-0679	HLM1B GPV-131 (SPARE TO OTHER HLM)		H1B	00	HLM1B N1F37	1	8	F	S
E-0680	HLM1B GPV-132 (SPARE TO OTHER HLM)		H1B	00	HLM1B N1F37	2	8	F	S
E-0681	HLM1B GPV-133 (SPARE TO OTHER HLM)		H1B	00	HLM1B N1F37	3	8	F	S
E-0682	HLM1B THIS SIDE LAUNCH MODE READY		H1B	00	HLM1B N1F37	4	8	F	S
E-0683	HLM1B OUT-OF-RANGE ALERT CODE COUNTER		H1B	00	HLM1B N1F38	1	8	F	S
E-0684	HLM1B ERRONEOUS ALERT CODE COUNTER		H1B	00	HLM1B N1F38	2	8	F	S
E-0685	HLM1B AACS ALERT CODE RECEIVED COUNTER		H1B	00	HLM1B N1F38	3	16	F	S
E-0686	HLM1B HEARTBEAT ENTRY COUNTER		H1B	00	HLM1B N1F39	1	8	F	S
E-0687	HLM1B HEARTBEAT ERROR COUNTER ACCUMULATED		H1B	00	HLM1B N1F39	2	8	F	S
E-0688	HLM1B LAST AACS ALERT CODE		H1B	00	HLM1B N1F39	3	8	F	S
E-0689	HLM1B AACS ALERT CODE RESPONSE COUNTER		H1B	00	HLM1B N1F39	4	8	F	S
E-0690	HLM1B COMMAND LOSS RESPONSE START TIME		H1B	00	HLM1B N1F40	1	24	F	S
E-0691	HLM1B AACS HEARTBEAT CODE		H1B	00	HLM1B N1F40	4	8	F	S
E-0692	HLM1B TF IMMINENT ALERT CODE COUNTER		H1B	00	HLM1B N1F41	1	8	F	S
E-0693	HLM1B TF ALL CLEAR ALERT CODE COUNTER		H1B	00	HLM1B N1F41	2	8	F	S
E-0694	HLM1B TF ALL CLEAR COMPLETION COUNTER		H1B	00	HLM1B N1F41	3	8	F	S
E-0695	HLM1B UV RESPONSE COUNTER		H1B	00	HLM1B N1F41	4	8	F	S
E-0696	HLM1B S/C F/P MONITOR ENABLE (PRIV)		H1B	00	HLM1B N1F42	1	8	F	S
E-0697	HLM1B UV DIODE UNSHORT COUNTER		H1B	00	HLM1B N1F42	2	8	F	S
E-0698	HLM1B OVERPRESSURE TEMPERATURE FLAG		H1B	00	HLM1B N1F42	3	8	F	S
E-0699	HLM1B UV TRIP/INVERTER SWITCH COUNTER		H1B	00	HLM1B N1F42	4	8	F	S
E-0700	HLM1B S/C F/P RESPONSE ENABLES (PRIV)		H1B	00	HLM1B N1F43	1	24	F	S
E-0701	HLM1B CDS POR RESPONSE COUNTER		H1B	00	HLM1B N1F43	4	8	F	S
E-0702	HLM1B F/P CONDITION (REQUESTS) ENABLES		H1B	00	HLM1B N1F44	1	24	F	S
E-0703	HLM1B RFLOSS RESPONSE COUNTER		H1B	00	HLM1B N1F44	4	8	F	S

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Table A2.2.8. Engineering Measurements
CDS - COMMAND AND DATA SUBSYSTEM

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS	COMM POS	NO. OF BITS	FLAGS	
E-0704	HLM1B F/P RESPONSE INACTIVE ENABLES		H1B 00	HLM1B N1F45 1	24	F	S
E-0705	HLM1B PRIME/BACKUP STATUS		H1B 00	HLM1B N1F45 4	8	F	S
E-0706	HLM1B MOS F/P RESPONSE ENABLES (NON-PRIV)		H1B 00	HLM1B N1F46 1	24	F	S
E-0707	HLM1B AACS STATUS		H1B 00	HLM1B N1F46 4	8	F	S
E-0708	HLM1B MOS F/P MONITOR ENABLE (NON-PRIV)		H1B 00	HLM1B N1F47 1	8	F	S
E-0709	HLM1B MOS THRUSTER TEMPERATURE ENABLE (NON-PRIV)		H1B 00	HLM1B N1F47 2	8	F	S
E-0710	HLM1B CMD LOSS RESET DELTA RIMS		H1B 00	HLM1B N1F47 3	16	F	S
E-0711	HLM1B SYSTEM FAULT STATUS		H1B 00	HLM1B N1F48 2	16	F	S
E-0712	HLM1B F/P MODE		H1B 00	HLM1B N1F48 4	8	F	S
E-0713	HLM1B F/P PATH CONTROL		H1B 00	HLM1B N1F48 1	8	F	S
E-0714	HLM1B GV-92 (SPARE TO OTHER HLM)		H1B 00	HLM1B N1F20 1	8	F	S
E-0715	HLM1B GV-93 (SPARE TO OTHER HLM)		H1B 00	HLM1B N1F20 2	8	F	S
E-0716	HLM1B GV-94 (SPARE TO OTHER HLM)		H1B 00	HLM1B N1F20 3	8	F	S
E-0717	HLM1B GV-95 (SPARE TO OTHER HLM)		H1B 00	HLM1B N1F20 4	8	F	S
E-0718	HLM1B GV-96 (SPARE TO OTHER HLM)		H1B 00	HLM1B N1F21 1	8	F	S
E-0719	HLM1B GV-97 (SPARE TO OTHER HLM)		H1B 00	HLM1B N1F21 2	8	F	S
E-0720	HLM1B GV-98 (SPARE TO OTHER HLM)		H1B 00	HLM1B N1F21 3	8	F	S
E-0721	HLM1B GV-99 (SPARE TO OTHER HLM)		H1B 00	HLM1B N1F21 4	8	F	S
E-0722	HLM1B SYS DIAGNOSTIC MSG QUEUE ENTRY 1		H1B 00	HLM1B N1F49 1	16	F	S
E-0723	HLM1B SYS DIAGNOSTIC MSG QUEUE ENTRY 2		H1B 00	HLM1B N1F49 3	16	F	S
E-0724	HLM1B SYS DIAGNOSTIC MSG QUEUE ENTRY 3		H1B 00	HLM1B N1F50 1	16	F	S
E-0725	HLM1B SYS DIAGNOSTIC MSG QUEUE ENTRY 4		H1B 00	HLM1B N1F50 3	16	F	S
E-0726	HLM1B SYS DIAGNOSTIC MSG QUEUE ENTRY 5		H1B 00	HLM1B N1F51 1	16	F	S
E-0727	HLM1B SYS DIAGNOSTIC MSG QUEUE ENTRY 6		H1B 00	HLM1B N1F51 3	16	F	S
E-0728	HLM1B SYS DIAGNOSTIC MSG QUEUE ENTRY 7		H1B 00	HLM1B N1F52 1	16	F	S
E-0729	HLM1B SYS DIAGNOSTIC MSG QUEUE ENTRY 8		H1B 00	HLM1B N1F52 3	16	F	S

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Table A2.2.8. Engineering Measurements
CDS - COMMAND AND DATA SUBSYSTEM

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS	COMM POS	NO. OF BITS	FLAGS	
E-0730	HLM1B CDS DIAGNOSTIC MSG QUEUE ENTRY 1		H1B 00	HLM1B N1F53 1	16	F	S
E-0731	HLM1B CDS DIAGNOSTIC MSG QUEUE ENTRY 2		H1B 00	HLM1B N1F53 3	16	F	S
E-0732	HLM1B CDS DIAGNOSTIC MSG QUEUE ENTRY 3		H1B 00	HLM1B N1F54 1	16	F	S
E-0733	HLM1B CDS DIAGNOSTIC MSG QUEUE ENTRY 4		H1B 00	HLM1B N1F54 3	16	F	S
E-0734	HLM1B CDS DIAGNOSTIC MSG QUEUE ENTRY 5		H1B 00	HLM1B N1F55 1	16	F	S
E-0735	HLM1B CDS DIAGNOSTIC MSG QUEUE ENTRY 6		H1B 00	HLM1B N1F55 3	16	F	S
E-0736	HLM1B CDS DIAGNOSTIC MSG QUEUE ENTRY 7		H1B 00	HLM1B N1F56 1	16	F	S
E-0737	HLM1B CDS DIAGNOSTIC MSG QUEUE ENTRY 8		H1B 00	HLM1B N1F56 3	16	F	S
E-0738	HLM1B CAP/IAP PROGRAM STATE FILE		H1B 00	HLM1B N1F57 1	32	F	S
E-0739	HLM1B F/P PROGRAM STATE FILE ENTRY 1		H1B 00	HLM1B N1F58 1	32	F	S
E-0740	HLM1B F/P PROGRAM STATE FILE ENTRY 2		H1B 00	HLM1B N1F59 1	32	F	S
E-0741	HLM1B F/P PROGRAM STATE FILE ENTRY 3		H1B 00	HLM1B N1F60 1	32	F	S
E-0742	HLM1B F/P PROGRAM STATE FILE ENTRY 4		H1B 00	HLM1B N1F61 1	32	F	S
E-0743	HLM1B F/P PROGRAM STATE FILE ENTRY 5		H1B 00	HLM1B N1F62 1	32	F	S
E-0744	HLM1B F/P PROGRAM STATE FILE ENTRY 6		H1B 00	HLM1B N1F63 1	32	F	S
E-0745	HLM1B F/P PROGRAM STATE FILE ENTRY 7		H1B 00	HLM1B N1F64 1	32	F	S
E-0746	HLM1B F/P PROGRAM STATE FILE ENTRY 8		H1B 00	HLM1B N1F65 1	32	F	S
E-0747	HLM1B F/P PROGRAM STATE FILE ENTRY 9		H1B 00	HLM1B N1F66 1	32	F	S
E-0748	HLM1B F/P PROGRAM STATE FILE ENTRY 10		H1B 00	HLM1B N1F67 1	32	F	S
E-0749	HLM1B S/S PROGRAM STATE FILE ENTRY 1		H1B 00	HLM1B N1F68 1	32	F	S
E-0750	HLM1B S/S PROGRAM STATE FILE ENTRY 2		H1B 00	HLM1B N1F69 1	32	F	S
E-0751	HLM1B S/S PROGRAM STATE FILE ENTRY 3		H1B 00	HLM1B N1F70 1	32	F	S
E-0752	HLM1B S/S PROGRAM STATE FILE ENTRY 4		H1B 00	HLM1B N1F71 1	32	F	S
E-0753	HLM1B S/S PROGRAM STATE FILE ENTRY 5		H1B 00	HLM1B N1F72 1	32	F	S
E-0754	HLM1B S/S PROGRAM STATE FILE ENTRY 6		H1B 00	HLM1B N1F73 1	32	F	S
E-0755	HLM1B S/S PROGRAM STATE FILE ENTRY 7		H1B 00	HLM1B N1F74 1	32	F	S

Table A2.2.8. Engineering Measurements
CDS - COMMAND AND DATA SUBSYSTEM

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS		COMM POS			NO. OF BITS	FLAGS	
E-0756	HLM1B S/S PROGRAM STATE FILE ENTRY 8		H1B	00	HLM1B	N1F75	1	32	F	S
E-0757	HLM1B S/S PROGRAM STATE FILE ENTRY 9		H1B	00	HLM1B	N1F76	1	32	F	S
E-0758	HLM1B S/S PROGRAM STATE FILE ENTRY 10		H1B	00	HLM1B	N1F77	1	32	F	S
E-0759	HLM1B S/S PROGRAM STATE FILE ENTRY 11		H1B	00	HLM1B	N1F78	1	32	F	S
E-0760	HLM1B S/S PROGRAM STATE FILE ENTRY 12		H1B	00	HLM1B	N1F79	1	32	F	S
E-0761	HLM1B S/S PROGRAM STATE FILE ENTRY 13		H1B	00	HLM1B	N1F80	1	32	F	S
E-0762	HLM1B S/S PROGRAM STATE FILE ENTRY 14		H1B	00	HLM1B	N1F81	1	32	F	S
E-0763	HLM1B S/S PROGRAM STATE FILE ENTRY 15		H1B	00	HLM1B	N1F82	1	32	F	S
E-0764	HLM1B S/S PROGRAM STATE FILE ENTRY 16		H1B	00	HLM1B	N1F83	1	32	F	S
E-0765	HLM1B S/S PROGRAM STATE FILE ENTRY 17		H1B	00	HLM1B	N1F84	1	32	F	S
E-0766	HLM1B S/S PROGRAM STATE FILE ENTRY 18		H1B	00	HLM1B	N1F85	1	32	F	S
E-0767	HLM1B S/S PROGRAM STATE FILE ENTRY 19		H1B	00	HLM1B	N1F86	1	32	F	S
E-0768	HLM1B S/S PROGRAM STATE FILE ENTRY 20		H1B	00	HLM1B	N1F87	1	32	F	S
E-0769	HLM1B S/S PROGRAM STATE FILE ENTRY 21		H1B	00	HLM1B	N1F88	1	32	F	S
E-0770	HLM1B S/S PROGRAM STATE FILE ENTRY 22		H1B	00	HLM1B	N1F89	1	32	F	S
E-0771	HLM1B S/S PROGRAM STATE FILE ENTRY 23		H1B	00	HLM1B	N1F90	1	32	F	S
E-0772	HLM1B BUFFERED BC COUNTER		H1B	00	HLM1B	N1S00	1	8	F	S
E-0773	HLM1B BC BUFFER ENTRY 1B		H1B	00	HLM1B	N1S01	1	8	F	S
E-0774	HLM1B BC BUFFER ENTRY 2B		H1B	00	HLM1B	N1S02	1	8	F	S
E-0775	HLM1B BC BUFFER ENTRY 3B		H1B	00	HLM1B	N1S03	1	8	F	S
E-0776	HLM1B BC BUFFER ENTRY 4B		H1B	00	HLM1B	N1S04	1	8	F	S
E-0777	HLM1B BC BUFFER ENTRY 5B		H1B	00	HLM1B	N1S05	1	8	F	S
E-0778	HLM1B BC BUFFER ENTRY 6B		H1B	00	HLM1B	N1S06	1	8	F	S
E-0779	HLM1B BC BUFFER ENTRY 7B		H1B	00	HLM1B	N1S07	1	8	F	S
E-0780	HLM1B BC BUFFER ENTRY 8B		H1B	00	HLM1B	N1S08	1	8	F	S
E-0781	HLM1B BC BUFFER ENTRY 9B		H1B	00	HLM1B	N1S09	1	8	F	S

Table A2.2.8. Engineering Measurements
CDS - COMMAND AND DATA SUBSYSTEM

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS		COMM POS			NO. OF BITS	FLAGS	
E-0782	HLM1B BC BUFFER ENTRY 10B		H1B	00	HLM1B	N1S10	1	8	F	S
E-0783	HLM1B BC BUFFER ENTRY 11B		H1B	00	HLM1B	N1S11	1	8	F	S
E-0784	HLM1B BC BUFFER ENTRY 12B		H1B	00	HLM1B	N1S12	1	8	F	S
E-0785	HLM1B BC BUFFER ENTRY 13B		H1B	00	HLM1B	N1S13	1	8	F	S
E-0786	HLM1B BC BUFFER ENTRY 14B		H1B	00	HLM1B	N1S14	1	8	F	S
E-0787	HLM1B BC BUFFER ENTRY 15B		H1B	00	HLM1B	N1S15	1	8	F	S
E-0788	HLM1B BC BUFFER ENTRY 16B		H1B	00	HLM1B	N1S16	1	8	F	S
E-0789	HLM1B CAP FC COUNTER		H1B	00	HLM1B	N1S17	1	8	F	S
E-0790	HLM1B CAP BC COUNTER		H1B	00	HLM1B	N1S18	1	8	F	S
E-0791	HLM1B IAP FC COUNTER		H1B	00	HLM1B	N1S19	1	8	F	S
E-0792	HLM1B IAP BC COUNTER		H1B	00	HLM1B	N1S20	1	8	F	S
E-0793	HLM1B SFP PROTECTED PATH CONTROL		H1B	00	HLM1B	N1S21	1	8	F	S
E-0794	HLM1B SPARE		H1B	00	HLM1B	N1S22	1	8	F	S
E-0795	HLM1B SPARE		H1B	00	HLM1B	N1S23	1	8	F	S
E-0796	HLM1B SPARE		H1B	00	HLM1B	N1S24	1	8	F	S
E-0797	HLM1B UPLINK IAP COUNTER		H1B	00	HLM1B	N1S25	1	8	F	S
E-0798	HLM1B UPLINK DAC COUNTER		H1B	00	HLM1B	N1S26	1	8	F	S
E-0799	HLM1B UPLINK NML COUNTER		H1B	00	HLM1B	N1S27	1	8	F	S
E-0800	HLM1B UPLINK IEX COUNTER		H1B	00	HLM1B	N1S28	1	8	F	S
E-0801	HLM1B UPLINK MSD(P) COUNTER		H1B	00	HLM1B	N1S29	1	8	F	S
E-0802	HLM1B UPLINK MSD(T) COUNTER		H1B	00	HLM1B	N1S30	1	8	F	S
E-0803	HLM1B UPLINK NMSL COUNTER		H1B	00	HLM1B	N1S31	1	8	F	S
E-0804	HLM1B UPLINK PMSL COUNTER		H1B	00	HLM1B	N1S32	1	8	F	S
E-0805	HLM1B UPLINK CAP COUNTER		H1B	00	HLM1B	N1S33	1	8	F	S
E-0806	HLM1B UPLINK NML/NMSL ERROR COUNTER		H1B	00	HLM1B	N1S34	1	8	F	S
E-0807	HLM1B UPLINK MSL ERROR COUNTER		H1B	00	HLM1B	N1S35	1	8	F	S

Table A2.2.8. Engineering Measurements
CDS - COMMAND AND DATA SUBSYSTEM

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS	COMM POS	NO. OF BITS	FLAGS	
E-0808	HLM1B SPARE		H1B 00	HLM1B N1S36 1	8	F	S
E-0809	HLM1B SPARE		H1B 00	HLM1B N1S37 1	8	F	S
E-0810	HLM1B SPARE		H1B 00	HLM1B N1S38 1	8	F	S
E-0811	HLM1B SPARE		H1B 00	HLM1B N1S39 1	8	F	S
E-0812	HLM1B SPARE		H1B 00	HLM1B N1S40 1	8	F	S
E-0813	HLM1B SPARE		H1B 00	HLM1B N1S41 1	8	F	S
E-0814	HLM1B SPARE		H1B 00	HLM1B N1S42 1	8	F	S
E-0815	HLM1B SPARE		H1B 00	HLM1B N1S43 1	8	F	S
E-0816	HLM1B SPARE		H1B 00	HLM1B N1S44 1	8	F	S
E-0817	HLM1B SPARE		H1B 00	HLM1B N1S45 1	8	F	S
E-0818	HLM1B SPARE		H1B 00	HLM1B N1S46 1	8	F	S
E-0819	HLM1B SPARE		H1B 00	HLM1B N1S47 1	8	F	S
E-0820	HLM1B SPARE		H1B 00	HLM1B N1S48 1	8	F	S
E-0821	HLM1B SYSTEM DIAGNOSTIC MESSAGE COUNTER		H1B 00	HLM1B N1S49 1	8	F	S
E-0822	HLM1B CDS DIAGNOSTIC MESSAGE COUNTER		H1B 00	HLM1B N1S50 1	8	F	S
E-0823	HLM1B MARK FC COUNTER		H1B 00	HLM1B N1S51 1	8	F	S
E-0824	HLM1B S/C THRUSTER TEMPERATURE ENABLE (PRIV)		H1B 00	HLM1B N1S52 1	8	F	S
E-0825	HLM1B CAP START LINK		H1B 00	HLM1B N1S53 1	8	F	S
E-0826	HLM1B F/P START LINK		H1B 00	HLM1B N1S54 1	8	F	S
E-0827	HLM1B IAP START LINK		H1B 00	HLM1B N1S55 1	8	F	S
E-0828	HLM1B S/S START LINK		H1B 00	HLM1B N1S56 1	8	F	S
E-0829	HLM1B UPLINK NMSL/PMSL SEQUENCE NUMBER		H1B 00	HLM1B N1S57 1	8	F	S
E-0830	HLM1B UPLINK CHECKSTATE		H1B 00	HLM1B N1S58 1	8	F	S
E-0831	HLM1B MISSING MESSAGE LIST 1		H1B 00	HLM1B N1S59 1	8	F	S
E-0832	HLM1B MISSING MESSAGE LIST 2		H1B 00	HLM1B N1S60 1	8	F	S
E-0833	HLM1B MISSING MESSAGE LIST 3		H1B 00	HLM1B N1S61 1	8	F	S

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NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS	COMM POS	NO. OF BITS	FLAGS
E-0834	HLM1B MISSING MESSAGE LIST 4		H1B 00	HLM1B N1S62 1	8	F S
E-0835	HLM1B MISSING MESSAGE LIST 5		H1B 00	HLM1B N1S63 1	8	F S
E-0836	HLM1B MISSING MESSAGE LIST 6		H1B 00	HLM1B N1S64 1	8	F S
E-0837	HLM1B MISSING MESSAGE LIST 7		H1B 00	HLM1B N1S65 1	8	F S
E-0838	HLM1B MISSING MESSAGE LIST 8		H1B 00	HLM1B N1S66 1	8	F S
E-0839	HLM1B MISSING MESSAGE LIST 9		H1B 00	HLM1B N1S67 1	8	F S
E-0840	HLM1B MISSING MESSAGE LIST 10		H1B 00	HLM1B N1S68 1	8	F S
E-0841	HLM1B MISSING MESSAGE LIST 11		H1B 00	HLM1B N1S69 1	8	F S
E-0842	HLM1B MISSING MESSAGE LIST 12		H1B 00	HLM1B N1S70 1	8	F S
E-0843	HLM1B MISSING MESSAGE LIST 13		H1B 00	HLM1B N1S71 1	8	F S
E-0844	HLM1B MISSING MESSAGE LIST 14		H1B 00	HLM1B N1S72 1	8	F S
E-0845	HLM1B MISSING MESSAGE LIST 15		H1B 00	HLM1B N1S73 1	8	F S
E-0846	HLM1B MISSING MESSAGE LIST 16		H1B 00	HLM1B N1S74 1	8	F S
E-0847	HLM1B MISSING MESSAGE LIST 17		H1B 00	HLM1B N1S75 1	8	F S
E-0848	HLM1B MISSING MESSAGE LIST 18		H1B 00	HLM1B N1S76 1	8	F S
E-0849	HLM1B MISSING MESSAGE LIST 19		H1B 00	HLM1B N1S77 1	8	F S
E-0850	HLM1B MISSING MESSAGE LIST 20		H1B 00	HLM1B N1S78 1	8	F S
E-0851	HLM1B MISSING MESSAGE LIST 21		H1B 00	HLM1B N1S79 1	8	F S
E-0852	HLM1B MISSING MESSAGE LIST 22		H1B 00	HLM1B N1S80 1	8	F S
E-0853	HLM1B MISSING MESSAGE LIST 23		H1B 00	HLM1B N1S81 1	8	F S
E-0854	HLM1B MISSING MESSAGE LIST 24		H1B 00	HLM1B N1S82 1	8	F S
E-0855	HLM1B MISSING MESSAGE LIST 25		H1B 00	HLM1B N1S83 1	8	F S
E-0856	HLM1B MISSING MESSAGE LIST 26		H1B 00	HLM1B N1S84 1	8	F S
E-0857	HLM1B MISSING MESSAGE LIST 27		H1B 00	HLM1B N1S85 1	8	F S
E-0858	HLM1B MISSING MESSAGE LIST 28		H1B 00	HLM1B N1S86 1	8	F S
E-0859	HLM1B MISSING MESSAGE LIST 29		H1B 00	HLM1B N1S87 1	8	F S

Table A2.2.8. Engineering Measurements
CDS - COMMAND AND DATA SUBSYSTEM

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS	COMM POS	NO. OF BITS	FLAGS
E-0881	LLM1B CC/DC BUFFER ENTRY 7		L1B 92	LLM1B N1D25 1	16	F S
E-0881			L1B 93			
E-0882	LLM1B PRIV CC/DC EXECUTED COUNTER		L1B 9E	LLM1B N1D34 1	8	F S
E-0883	LLM1B NON-PRIV CC/DC EXECUTED COUNTER		L1B 9F	LLM1B N1D34 2	8	F S
E-0884	LLM1B PRIV CC/DC (POWER CODE) QUEUED COUNTER		L1B A0	LLM1B N1D35 1	8	F S
E-0885	LLM1B NON-PRIV CC/DC (POWER CODE) QUEUED COUNTER		L1B A1	LLM1B N1D35 2	8	F S
E-0886	LLM1B TEMPERATURE CC/DC QUEUED COUNTER		L1B A2	LLM1B N1D36 1	8	F S
E-0887	LLM1B DAC CC/DC QUEUED COUNTER		L1B A3	LLM1B N1D36 2	8	F S
E-0888	LLM1B AACS POWER CODES QUEUED COUNTER		L1B A4	LLM1B N1D37 1	8	F S
E-0889	LLM1B AACS POWER CODES REJECTED COUNTER		L1B A5	LLM1B N1D37 2	8	F S
E-0890	LLM1B EPD/OLS CC/DC'S QUEUED COUNTER		L1B A6	LLM1B N1D38 1	8	F S
E-0891	LLM1B LAST VALID AACS POWER CODE		L1B A7	LLM1B N1D38 2	8	F S
E-0892	LLM1B FC'S RECEIVED COUNTER		L1B A8	LLM1B N1D47 1	8	F S
E-0893	LLM1B FC'S EXECUTED COUNTER		L1B A9	LLM1B N1D47 2	8	F S
E-0894	LLM1B LAST VALID FC ID		L1B AA	LLM1B N1D48 1	8	F S
E-0895	LLM1B FC'S REJECTED COUNTER		L1B AB	LLM1B N1D48 2	8	F S
E-0896	LLM1B CHANGE PACKET SELECTION COUNTER		L1B AC	LLM1B N1D49 1	8	F S
E-0897	LLM1B BUS TRANSACTIONS SENT COUNTER		L1B AD	LLM1B N1D49 2	8	F S
E-0898	LLM1B CHANGE PACKET TIMING COUNTER		L1B AE	LLM1B N1D50 1	8	F S
E-0899	LLM1B UPDATE PACKET MENU COUNTER		L1B AF	LLM1B N1D50 2	8	F S
E-0900	LLM1B AACS POWER CODES RECEIVED COUNTER		L1B B0	LLM1B N1D51 1	16	F S
E-0900			L1B B1			
E-0901	LLM1B FLAG STATUS		L1B B6	LLM1B N1D60 1	8	F S
E-0902	LLM1B CDS DIAGNOSTIC MESSAGE COUNTER		L1B B7	LLM1B N1D60 2	8	F S
E-0903	LLM1B CDS DIAGNOSTIC MSG QUEUE ENTRY 1		L1B B8	LLM1B N1D61 1	16	F S
E-0903			L1B B9			

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Table A2.2.8. Engineering Measurements
CDS - COMMAND AND DATA SUBSYSTEM

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE	POS	COMM POS	NO. OF BITS	FLAGS
E-0860	HLM1B MISSING MESSAGE LIST 30		H1B	00	HLM1B N1S88 1	8	F S
E-0861	HLM1B MISSING MESSAGE LIST 31		H1B	00	HLM1B N1S89 1	8	F S
E-0862	HLM1B MISSING MESSAGE LIST 32		H1B	00	HLM1B N1S90 1	8	F S
E-0865	LLM1B DMS FCS EXECUTED COUNTER		L1B	94	LLM1B N1D28 1	8	F S
E-0866	LLM1B DMS FCS REJECTED COUNTER		L1B	95	LLM1B N1D28 2	8	F S
E-0867	LLM1B DMS CMDS SENT COUNTER		L1B	96	LLM1B N1D29 1	8	F S
E-0868	LLM1B LAST DMS COMMAND SENT		L1B	97	LLM1B N1D29 2	8	F S
E-0869	LLM1B EPD/PLS ENABLE STATUS		L1B	98	LLM1B N1D30 1	8	F S
E-0870	LLM1B LAST CC/DC RIM COUNT MSB/ISB		L1B	80	LLM1B N1D08 1	16	F S
E-0870			L1B	81			
E-0871	LLM1B LAST CC/DC RIM COUNT LSB		L1B	82	LLM1B N1D09 1	8	F S
E-0872	LLM1B LAST CC/DC MOD91		L1B	83	LLM1B N1D09 2	8	F S
E-0873	LLM1B LAST CC/DC MOD10		L1B	84	LLM1B N1D10 1	8	F S
E-0874	LLM1B LAST CC/DC POINTER		L1B	85	LLM1B N1D10 2	8	F S
E-0875	LLM1B CC/DC BUFFER ENTRY 1		L1B	86	LLM1B N1D11 1	16	F S
E-0875			L1B	87			
E-0876	LLM1B CC/DC BUFFER ENTRY 2		L1B	88	LLM1B N1D12 1	16	F S
E-0876			L1B	89			
E-0877	LLM1B CC/DC BUFFER ENTRY 3		L1B	8A	LLM1B N1D21 1	16	F S
E-0877			L1B	8B			
E-0878	LLM1B CC/DC BUFFER ENTRY 4		L1B	8C	LLM1B N1D22 1	16	F S
E-0878			L1B	8D			
E-0879	LLM1B CC/DC BUFFER ENTRY 5		L1B	8E	LLM1B N1D23 1	16	F S
E-0879			L1B	8F			
E-0880	LLM1B CC/DC BUFFER ENTRY 6		L1B	90	LLM1B N1D24 1	16	F S
E-0880			L1B	91			

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Table A2.2.8. Engineering Measurements
CDS - COMMAND AND DATA SUBSYSTEM

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS	COMM POS	NO. OF BITS	FLAGS
E-0904	LLM1B CDS DIAGNOSTIC MSG QUEUE ENTRY 2		L1B BA	LLM1B N1D62 1	16	F S
E-0904			L1B BB			
E-0905	LLM1B CDS DIAGNOSTIC MSG QUEUE ENTRY 3		L1B BC	LLM1B N1D63 1	16	F S
E-0905			L1B BD			
E-0906	LLM1B CDS DIAGNOSTIC MSG QUEUE ENTRY 4		L1B BE	LLM1B N1D64 1	16	F S
E-0906			L1B BF			
E-0907	LLM1B SPARE		L1B C0	LLM1B N1D73 1	8	F S
E-0908	LLM1B SYSTEM DIAGNOSTIC MESSAGE COUNTER		L1B C1	LLM1B N1D73 2	8	F S
E-0909	LLM1B SYS DIAGNOSTIC MSG QUEUE ENTRY 1		L1B C2	LLM1B N1D74 1	16	F S
E-0909			L1B C3			
E-0910	LLM1B SYS DIAGNOSTIC MSG QUEUE ENTRY 2		L1B C4	LLM1B N1D75 1	16	F S
E-0910			L1B C5			
E-0911	LLM1B SYS DIAGNOSTIC MSG QUEUE ENTRY 3		L1B C6	LLM1B N1D76 1	16	F S
E-0911			L1B C7			
E-0912	LLM1B SYS DIAGNOSTIC MSG QUEUE ENTRY 4		L1B C8	LLM1B N1D77 1	16	F S
E-0912			L1B C9			
E-0913	LLM1B ERROR WORD-1 IOSL-0		L1B CE	LLM1B N1D86 1	8	F S
E-0914	LLM1B ERROR WORD-2 IOSL-1		L1B CF	LLM1B N1D86 2	8	F S
E-0915	LLM1B DAC MAP PART-1		L1B D0	LLM1B N1D87 1	16	F S
E-0915			L1B D1			
E-0916	LLM1B DAC MAP PART-2		L1B D2	LLM1B N1D88 1	16	F S
E-0916			L1B D3			
E-0917	LLM1B DACS RECEIVED COUNTER		L1B D4	LLM1B N1D89 1	8	F S
E-0918	LLM1B DACS REJECTED COUNTER		L1B D5	LLM1B N1D89 2	8	F S
E-0919	LLM1B DAC BC COUNTER		L1B D6	LLM1B N1D90 1	8	F S
E-0920	LLM1B DAC CHECKSUM ERROR COUNTER		L1B D7	LLM1B N1D90 2	8	F S

Table A2.2.8. Engineering Measurements
CDS - COMMAND AND DATA SUBSYSTEM

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS		COMM POS		NO. OF BITS	FLAGS	
E-0921	LLM1B S/C TEMPERATURE ENABLE STATUS (PRIV)		L1B	B4	LLM1B N1D55	1	8	F	S
E-0922	LLM1B MOS TEMPERATURE ENABLE STATUS (NON-PRIV)		L1B	B5	LLM1B N1D55	2	8	F	S
E-0923	LLM1B DMS TAPE POSITION ESTIMATE MSB		L1B	FD	LLM1B T1S00	1	8	F	S
E-0924	LLM1B DMS TAPE POSITION ESTIMATE LSB		L1B	FE	LLM1B T2S00	1	8	F	S
E-0925	LLM1B MEMORY COPY FC COUNTER		L1B	99	LLM1B N1D30	2	8	F	S
E-0926	LLM1B TEMPERATURE BC COUNTER		L1B	9A	LLM1B N1D31	1	8	F	S
E-0927	LLM1B MEMORY TWEAK FC COUNTER		L1B	9B	LLM1B N1D31	2	8	F	S
E-0928	LLM1B CHECKSUM RESULT		L1B	9C	LLM1B N1D32	1	8	F	S
E-0929	LLM1B CHECKSUM COUNTER		L1B	9D	LLM1B N1D32	2	8	F	S
E-0930	LLM2B LAST CC/DC RIM COUNT MSB/ISB		L2B	80	LLM2B N1D08	1	16	F	S
E-0930			L2B	81					
E-0931	LLM2B LAST CC/DC RIM COUNT LSB		L2B	82	LLM2B N1D09	1	8	F	S
E-0932	LLM2B LAST CC/DC MOD91		L2B	83	LLM2B N1D09	2	8	F	S
E-0933	LLM2B LAST CC/DC MOD10		L2B	84	LLM2B N1D10	1	8	F	S
E-0934	LLM2B LAST CC/DC POINTER		L2B	85	LLM2B N1D10	2	8	F	S
E-0935	LLM2B CC/DC BUFFER ENTRY 1		L2B	86	LLM2B N1D11	1	16	F	S
E-0935			L2B	87					
E-0936	LLM2B CC/DC BUFFER ENTRY 2		L2B	88	LLM2B N1D12	1	16	F	S
E-0936			L2B	89					
E-0937	LLM2B CC/DC BUFFER ENTRY 3		L2B	8A	LLM2B N1D21	1	16	F	S
E-0937			L2B	8B					
E-0938	LLM2B CC/DC BUFFER ENTRY 4		L2B	8C	LLM2B N1D22	1	16	F	S
E-0938			L2B	8D					
E-0939	LLM2B CC/DC BUFFER ENTRY 5		L2B	8E	LLM2B N1D23	1	16	F	S
E-0939			L2B	8F					
E-0940	LLM2B CC/DC BUFFER ENTRY 6		L2B	90	LLM2B N1D24	1	16	F	S
E-0940			L2B	91					

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Table A2.2.8. Engineering Measurements
CDS - COMMAND AND DATA SUBSYSTEM

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS		COMM POS	NO. OF BITS	FLAGS
E-0941	LLM2B CC/DC BUFFER ENTRY 7		L2B	92	LLM2B N1D25 1	16	F S
E-0941			L2B	93			
E-0942	LLM2B PRIV CC/DC EXECUTED COUNTER		L2B	9E	LLM2B N1D34 1	8	F S
E-0943	LLM2B NON-PRIV CC/DC EXECUTED COUNTER		L2B	9F	LLM2B N1D34 2	8	F S
E-0944	LLM2B PRIV CC/DC/(POWER CODE) QUEUED COUNTER		L2B	A0	LLM2B N1D35 1	8	F S
E-0945	LLM2B NON-PRIV CC/DC/(POWER CODE) QUEUED COUNTER		L2B	A1	LLM2B N1D35 2	8	F S
E-0946	LLM2B TEMPERATURE CC/DC QUEUED COUNTER		L2B	A2	LLM2B N1D36 1	8	F S
E-0947	LLM2B DAC CC/DC QUEUED COUNTER		L2B	A3	LLM2B N1D36 2	8	F S
E-0948	LLM2B AACS POWER CODES QUEUED COUNTER		L2B	A4	LLM2B N1D37 1	8	F S
E-0949	LLM2B AACS POWER CODES REJECTED COUNTER		L2B	A5	LLM2B N1D37 2	8	F S
E-0950	LLM2B EPD/PLS CC/DC QUEUED COUNTER (DUMMY)		L2B	A6	LLM2B N1D38 1	8	F S
E-0951	LLM2B LAST VALID AACS POWER CODE		L2B	A7	LLM2B N1D38 2	8	F S
E-0952	LLM2B FC'S RECEIVED COUNTER		L2B	A8	LLM2B N1D47 1	8	F S
E-0953	LLM2B FC'S EXECUTED COUNTER		L2B	A9	LLM2B N1D47 2	8	F S
E-0954	LLM2B LAST VALID FC ID		L2B	AA	LLM2B N1D48 1	8	F S
E-0955	LLM2B FC'S REJECTED COUNTER		L2B	AB	LLM2B N1D48 2	8	F S
E-0956	LLM2B CHANGE PACKET SELECTION COUNTER		L2B	AC	LLM2B N1D49 1	8	F S
E-0957	LLM2B BUS TRANSACTIONS SENT COUNTER (DUMMY)		L2B	AD	LLM2B N1D49 2	8	F S
E-0958	LLM2B CHANGE PACKET TIMING COUNTER		L2B	AE	LLM2B N1D50 1	8	F S
E-0959	LLM2B UPDATE PACKET MENU COUNTER		L2B	AF	LLM2B N1D50 2	8	F S
E-0960	LLM2B AACS POWER CODES RECEIVED COUNTER		L2B	B0	LLM2B N1D51 1	16	F S
E-0960			L2B	B1			
E-0961	LLM2B FLAG STATUS		L2B	B6	LLM2B N1D60 1	8	F S
E-0962	LLM2B CDS DIAGNOSTIC MESSAGE COUNTER		L2B	B7	LLM2B N1D60 2	8	F S
E-0963	LLM2B CDS DIAGNOSTIC MSG QUEUE ENTRY 1		L2B	B8	LLM2B N1D61 1	16	F S
E-0963			L2B	B9			

Table A2.2.8. Engineering Measurements
CDS - COMMAND AND DATA SUBSYSTEM

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS	COMM POS	NO. OF BITS	FLAGS
E-0964	LLM2B CDS DIAGNOSTIC MSG QUEUE ENTRY 2		L2B BA	LLM2B N1D62 1	16	F S
E-0964			L2B BB			
E-0965	LLM2B CDS DIAGNOSTIC MSG QUEUE ENTRY 3		L2B BC	LLM2B N1D63 1	16	F S
E-0965			L2B BD			
E-0966	LLM2B CDS DIAGNOSTIC MSG QUEUE ENTRY 4		L2B BE	LLM2B N1D64 1	16	F S
E-0966			L2B BF			
E-0967	LLM2B SPARE		L2B C0	LLM2B N1D73 1	8	F S
E-0968	LLM2B SYSTEM DIAGNOSTIC MESSAGE COUNTER		L2B C1	LLM2B N1D73 2	8	F S
E-0969	LLM2B SYS DIAGNOSTIC MSG QUEUE ENTRY 1		L2B C2	LLM2B N1D74 1	16	F S
E-0969			L2B C3			
E-0970	LLM2B SYS DIAGNOSTIC MSG QUEUE ENTRY 2		L2B C4	LLM2B N1D75 1	16	F S
E-0970			L2B C5			
E-0971	LLM2B SYS DIAGNOSTIC MSG QUEUE ENTRY 3		L2B C6	LLM2B N1D76 1	16	F S
E-0971			L2B C7			
E-0972	LLM2B SYS DIAGNOSTIC MSG QUEUE ENTRY 4		L2B C8	LLM2B N1D77 1	16	F S
E-0972			L2B C9			
E-0973	LLM2B ERROR WORD-1 IOSL-0		L2B CE	LLM2B N1D86 1	8	F S
E-0974	LLM2B ERROR WORD-2 IOSL-1		L2B CF	LLM2B N1D86 2	8	F S
E-0975	LLM2B DAC MAP PART-1		L2B D0	LLM2B N1D87 1	16	F S
E-0975			L2B D1			
E-0976	LLM2B DAC MAP PART-2		L2B D2	LLM2B N1D88 1	16	F S
E-0976			L2B D3			
E-0977	LLM2B DACS RECEIVED COUNTER		L2B D4	LLM2B N1D89 1	8	F S
E-0978	LLM2B DACS REJECTED COUNTER		L2B D5	LLM2B N1D89 2	8	F S
E-0979	LLM2B DAC BC COUNTER (DUMMY)		L2B D6	LLM2B N1D90 1	8	F S

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Table A2.2.8. Engineering Measurements
CDS - COMMAND AND DATA SUBSYSTEM

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS	COMM POS	NO. OF BITS	FLAGS
E-0980	LLM2B DAC CHECKSUM ERROR COUNTER		L2B D7	LLM2B N1D90 2	8	F S
E-0981	LLM2B S/C TEMPERATURE ENABLE STATUS (PRIV)		L2B B4	LLM2B N1D55 1	8	F S
E-0982	LLM2B MOS TEMPERATURE ENABLE STATUS (NON-PRIV)		L2B B5	LLM2B N1D55 2	8	F S
E-1100	CDS +5 VDC P/C A STATUS		T1A 10	LLM1A N1D04 1	8	F A
E-1101	CDS +10 VDC P/C A STATUS		T1A 11	LLM1A N1D04 2	8	F A
E-1102	CDS +12 VDC P/C A STATUS		T1A 12	LLM1A N1D05 1	8	F A
E-1103	CDS -12 VDC P/C A STATUS		T1A 13	LLM1A N1D05 2	8	F A
E-1104	CDS RELAY VOLTAGE P/C A STATUS		T1A 14	LLM1A N1D06 1	8	F A
E-1105	CDS MEMORY KEEP-ALIVE PPS-A STATUS		T1A 15	LLM1A N1D06 2	8	F A
E-1106	CDS +10 VOLT CURRENT P/C A STATUS		T1A 16	LLM1A N1D39 1	8	F A
E-1107	CDS HARDWARE SPARE		T1A 17	LLM1A N1D39 2	8	F A
E-1108	CDS +3 VOLT ADC-B STATUS		T1A 28	LLM1A N1D40 1	8	F A
E-1109	CDS BACKUP DESPUN MEASUREMENT - LLM1A		T1A 4B	LLM1A N1D41 1	8	F A
E-1110	CDS BACKUP DESPUN MEASUREMENT (FILTERED) - LLM1A		T1A 2E	LLM1A N1D41 2	8	F A
E-1120	CDS +5 VDC P/C B STATUS		T1B 10	LLM1B N1D04 1	8	F A
E-1121	CDS +10 VDC P/C B STATUS		T1B 11	LLM1B N1D04 2	8	F A
E-1122	CDS +12 VDC P/C B STATUS		T1B 12	LLM1B N1D05 1	8	F A
E-1123	CDS -12 VDC P/C B STATUS		T1B 13	LLM1B N1D05 2	8	F A
E-1124	CDS RELAY VOLTAGE P/C B STATUS		T1B 14	LLM1B N1D06 1	8	F A
E-1125	CDS MEMORY KEEP-ALIVE PPS-B STATUS		T1B 15	LLM1B N1D06 2	8	F A
E-1126	CDS +10 VOLT CURRENT P/C B STATUS		T1B 16	LLM1B N1D39 1	8	F A
E-1127	CDS HARDWARE SPARE		T1B 17	LLM1B N1D39 2	8	F A
E-1128	CDS +3 VOLT ADC-A STATUS		T1B 28	LLM1B N1D40 1	8	F A
E-1129	CDS BACKUP DESPUN MEASUREMENT - LLM1B		T1B 4B	LLM1B N1D41 1	8	F A
E-1130	CDS BACKUP DESPUN MEASUREMENT (FILTERED) - LLM1B		T1B 2E	LLM1B N1D41 2	8	F A
E-1135	UNUSED					

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Table A2.2.8. Engineering Measurements
CDS - COMMAND AND DATA SUBSYSTEM

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE		TREE POS		COMM POS	NO. OF BITS	FLAGS	
E-1136	+3VDC TO RRA POS POT 2	0. TO 6.0	VDC	T2A	25	LLM2A N1D06 1	8	F	A
E-1137	+3VDC TO RRA POS POT 1 (ALSO ADC-C)	0. TO 6.0	VDC	BDM	02		8		A
E-1138	DESPUN COMMUTATOR TREE OUTPUT			BDM	03		8		
E-1139	DESPUN SIGNAL GROUND	0. TO 3.0	VDC	BDM	04		8		A
E-1140	FILTER CALIBRATION VOLTAGE (+2.73 V)	0. TO 3.3	VDC	BDM	05		8		A
E-1141	COM-1A TREE-1 ZERO REF			T1A	1F		8	V	A
E-1142	COM-1A TREE-2 ZERO REF			T1A	2F		8	V	A
E-1143	COM-1A TREE-3 ZERO REF			T1A	3F		8	V	A
E-1144	COM-1A TREE-4 ZERO REF			T1A	4F		8	V	A
E-1145	COM-1A TREE-5 ZERO REF			T1A	5F		8	V	A
E-1146	COM-1A TREE-6 ZERO REF			T1A	6F		8	V	A
E-1147	COM-1A TREE-7 ZERO REF			T1A	7F		8	V	A
E-1148	COM-1B TREE-1 ZERO REF			T1B	1F		8	V	A
E-1149	COM-1B TREE-2 ZERO REF			T1B	2F		8	V	A
E-1150	COM-1B TREE-3 ZERO REF			T1B	3F		8	V	A
E-1151	COM-1B TREE-4 ZERO REF			T1B	4F		8	V	A
E-1152	COM-1B TREE-5 ZERO REF			T1B	5F		8	V	A
E-1153	COM-1B TREE-6 ZERO REF			T1B	6F		8	V	A
E-1154	COM-1B TREE-7 ZERO REF			T1B	7F		8	V	A
E-1155	COM-2A TREE-1 ZERO REF			T2A	1F		8	V	A
E-1156	COM-2A TREE-2 ZERO REF			T2A	2F		8	V	A
E-1157	COM-2A TREE-3 ZERO REF			T2A	3F		8	V	A
E-1158	COM-2A TREE-4 ZERO REF			T2A	4F		8	V	A
E-1159	COM-2A TREE-5 ZERO REF			T2A	5F		8	V	A
E-1160	COM-2A TREE-6 ZERO REF			T2A	6F		8	V	A
E-1161	COM-2A TREE-7 ZERO REF			T2A	7F		8	V	A

Table A2.2.8. Engineering Measurements
AACS - ATTITUDE AND ARTICULATION CONTROL SUBSYSTEM

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NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS	COMM POS	NO. OF BITS	FLAGS	
E-1200	COMBINED STAR CODE		AACS	AACS T2D11 1	16	B	S
E-1201	POWER STATE #1		AACS	AACS N1D31 1	16	F	S
E-1201				AACS N1D46 1	0		
E-1202	SCAN POINTING TYPE		AACS	AACS T1D09 1	16	F	S
E-1203	STAR IDENTIFICATION		AACS	AACS T1D03 1	16	F	S
E-1203				AACS T1D10 1	0		
E-1204	-Z1A 11 MS COUNT (LS)		AACS	AACS T2D06 1	16	F	S
E-1205	-Z2A 11 MS COUNT (LS)		AACS	AACS T3D06 1	16	F	S
E-1206	-Z1B 11 MS COUNT (LS)		AACS	AACS T2D07 1	16	F	S
E-1207	-Z2B 11 MS COUNT (LS)		AACS	AACS T3D07 1	16	F	S
E-1208	ROTOR SPIN RATE		AACS	AACS T1D08 1	16	B	S
E-1209	THRUSTER COUNTER		AACS	AACS T1D11 1	16	F	S
E-1210	RPM HEATER CYCLE COUNT		AACS	AACS N1D23 1	16	F	S
E-1211	LAST "BC" COMMAND		AACS	AACS T2D02 1	16	F	S
E-1212	TASK ABORT COUNT		AACS	AACS N1D10 1	16	F	S
E-1213	CURRENT TASK ID		AACS	AACS T1D02 1	16	F	S
E-1215	SBA ENCODER RATE		AACS	AACS T3D08 1	16	F	S
E-1216	STAR CLOCK TRANSIT TIME		AACS		16	V	S
E-1217	+P1A 11 MS COUNT (LS)		AACS	AACS T2D04 1	16	F	S
E-1218	+L1B 11 MS COUNT (LS)		AACS	AACS T2D05 1	16	F	S
E-1219	-S1A 11 MS COUNT (LS)		AACS	AACS T1D04 1	16	F	S
E-1220	+S2A 11 MS COUNT (LS)		AACS	AACS T1D06 1	16	F	S
E-1221	ACQUISITION SENSOR PULSE CENTER TIME		AACS		16	V	S
E-1222	STAR CLOCK ANGLE		AACS	AACS T2D03 1	16	V	S
E-1222				AACS T2D10 1	0		

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Table A2.2.8. Engineering Measurements
AACS - ATTITUDE AND ARTICULATION CONTROL SUBSYSTEM

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS	COMM POS	NO. OF BITS	FLAGS	
E-1223	AS MINIMUM OUTPUT VALUE		AACS		16	V	S
E-1224	STAR ELEVATION ANGLE		AACS	AACS T3D03 1	16	V	S
E-1224				AACS T3D10 1	0		
E-1225	LAST FAULT CODE		AACS	AACS T3D00 1	16	F	S
E-1226	SPUN CONFIGURATION		AACS	AACS T1D00 1	16	B	S
E-1227	DESPUN CONFIGURATION		AACS	AACS T2D00 1	16	B	S
E-1228	SAS ENCODER RATE		AACS	AACS T3D09 1	16	F	S
E-1229	STAR CONE TRANSIT TIME		AACS		16	V	S
E-1230	+P2A 11 MS COUNT (LS)		AACS	AACS T3D04 1	16	F	S
E-1231	+L2B 11 MS COUNT (LS)		AACS	AACS T3D05 1	16	F	S
E-1232	-S1B 11 MS COUNT (LS)		AACS	AACS T1D05 1	16	F	S
E-1233	+S2B 11 MS COUNT (LS)		AACS	AACS T1D07 1	16	F	S
E-1234	ACQUISITION SENSOR PULSE WIDTH		AACS		16	V	S
E-1235	AS MAXIMUM OUTPUT VALUE		AACS		16	V	S
E-1237	CYCLE SLIP COUNTER		AACS	AACS N1D57 1	16	F	S
E-1238	IDLE TIME COUNTER		AACS		16	V	S
E-1239	HGA POINTING ERROR		AACS	AACS N1D04 1	16	F	S
E-1239				AACS N1D45 1	0		
E-1239				AACS N1D55 1	0		
E-1240	THRUSTER CONFIGURATION		AACS		16	V	S
E-1241	S/S THRESHOLD DEFAULT		AACS		16	V	S
E-1242	S/S THRESHOLD		AACS	AACS T3D11 1	16	F	S
E-1243	STAR BACKGROUND		AACS		16	V	S
E-1244	EARTH STAR 1 POINTER		AACS	AACS N1D60 1	16	F	S
E-1245	MANEUVER STAR 1 POINTER		AACS	AACS N1D61 1	16	F	S

Table A2.2.8. Engineering Measurements
AACS - ATTITUDE AND ARTICULATION CONTROL SUBSYSTEM

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NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS	COMM POS	NO. OF BITS	FLAGS
E-1246	SUN STAR 1 POINTER		AACS	AACS N1D63 1	16	F S
E-1247	ALERT CODE COUNT		AACS	AACS N1D87 1	16	F S
E-1248	POWER CODE COUNT		AACS	AACS N1D08 1	16	F S
E-1248				AACS N1D84 1		
E-1249	GYRO DRIFT M		AACS	AACS N1D11 1	16	F S
E-1250	GYRO DRIFT N		AACS	AACS N1D12 1	16	F S
E-1251	GYRO DRIFT L		AACS	AACS N1D13 1	16	F S
E-1252	LBA 1 POSITION		AACS	AACS N1D14 1	16	B S
E-1253	LBA 2 POSITION		AACS	AACS N1D15 1	16	B S
E-1254	ISOVALVE AND PDE ANNEX STATUS		AACS	AACS T1D12 1	16	B S
E-1255	ROTOR ATTITUDE FAULT COUNT		AACS	AACS N1D36 1	16	F S
E-1256	INERTIAL OBSERVER FAULT COUNT		AACS	AACS N1D49 1	16	F S
E-1257	SUCCESSFUL COMMAND COUNTER		AACS	AACS T3D02 1	16	F S
E-1258	A/D REFERENCE VOLTAGE - LOW		AACS		16	V S
E-1259	A/D REFERENCE VOLTAGE - HIGH		AACS		16	V S
E-1260	SPIN RATE ERROR		AACS	AACS N1D44 1	16	F S
E-1261	BAD COMMAND COUNT 1		AACS	AACS N1D25 1	16	F S
E-1262	BAD COMMAND COUNT 2		AACS	AACS N1D26 1	16	F S
E-1263	FUNCTION STATUS		AACS	AACS N1D27 1	16	F S
E-1264	IVP STATUS		AACS	AACS N1D28 1	16	F S
E-1265	AACS STATUS #5		AACS	AACS T1D01 1	16	F S
E-1266	HGA SLOT #		AACS	AACS N1D03 1	16	F S
E-1267	HGA DEADBAND		AACS	AACS N1D02 1	16	F S
E-1270	LBA ABORT COUNT		AACS	AACS N1D35 1	16	F S
E-1276	SPIN RATE DEADBAND		AACS	AACS N1D43 1	16	F S
E-1277	RESYNCHRONIZATION COUNTER		AACS	AACS N1D81 1	16	F S

Table A2.2.8. Engineering Measurements
AACS - ATTITUDE AND ARTICULATION CONTROL SUBSYSTEM

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS	COMM POS	NO. OF BITS	FLAGS
E-1278	SLEW COUNT		AACS	AACS N1D29 1	16	F S
E-1279	SUN AVOIDANCE SLEW COUNT		AACS	AACS N1D30 1	16	F S
E-1280	MISSED SLEW TIME (MS)		AACS		16	V S
E-1281	MISSED SLEW TIME (LS)		AACS	AACS N1D58 1	16	F S
E-1282	MISSED SLEW COUNTER		AACS	AACS N1D59 1	16	F S
E-1283	CONFIGURATION FAIL COUNT		AACS		16	V S
E-1284	CONFIGURATION READY WORD		AACS	AACS N1D32 1	16	F S
E-1284			AACS	AACS N1D47 1	16	F S
E-1285	SS THRESHOLD MODE		AACS		16	V S
E-1288	RANGE 1 CHECKSUM		AACS	AACS N1D66 1	16	F S
E-1289	RANGE 2 CHECKSUM		AACS	AACS N1D67 1	16	F S
E-1290	SSSR RETURN CODE		AACS		8	V S
E-1291	DELTA CLOCK SLEW ANGLE		AACS		16	V S
E-1292	DELTA CONE SLEW ANGLE		AACS		16	V S
E-1293	SBA ENCODER ANGLE (CLOCK)		AACS	AACS T2D08 1	16	F S
E-1294	SAS ENCODER ANGLE (CONE)		AACS	AACS T2D09 1	16	F S
E-1295	S/S I/O ERROR COUNTER		AACS	AACS N1D07 1	16	F S
E-1296	WRITE PROTECT LIMITS - ON LINE CPU		AACS	AACS N1D76 1	16	F S
E-1297	WRITE PROTECT LIMITS - OFFLINE CPU		AACS	AACS N1D77 1	16	F S
E-1298	WRITE PROTECT LIMITS - ONLINE DMA		AACS	AACS N1D78 1	16	F S
E-1299	WRITE PROTECT LIMITS - OFFLINE DMA		AACS	AACS N1D79 1	16	F S
E-1303	TRICKLE MEMORY READOUT ADDRESS		AACS	AACS N2D00 1	16	B S
E-1304	TRICKLE MEMORY READOUT DATA		AACS	AACS N2D01 1	16	F S
E-1304				AACS N2D02 1		
E-1304				AACS N2D03 1		
E-1304				AACS N2D04 1		

Table A2.2.8. Engineering Measurements
AACS - ATTITUDE AND ARTICULATION CONTROL SUBSYSTEM

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NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS	COMM POS	NO. OF BITS	FLAGS
E-1304			AACS	N2D05	1	
E-1304			AACS	N2D06	1	
E-1304			AACS	N2D07	1	
E-1304			AACS	N2D08	1	
E-1304			AACS	N2D09	1	
E-1304			AACS	N2D10	1	
E-1304			AACS	N2D11	1	
E-1304			AACS	N2D12	1	
E-1304			AACS	N2D13	1	
E-1304			AACS	N2D14	1	
E-1304			AACS	N2D15	1	
E-1304			AACS	N2D16	1	
E-1304			AACS	N2D17	1	
E-1304			AACS	N2D18	1	
E-1304			AACS	N2D19	1	
E-1304			AACS	N2D20	1	
E-1304			AACS	N2D21	1	
E-1304			AACS	N2D22	1	
E-1304			AACS	N2D23	1	
E-1304			AACS	N2D24	1	
E-1304			AACS	N2D25	1	
E-1304			AACS	N2D26	1	
E-1304			AACS	N2D27	1	
E-1304			AACS	N2D28	1	
E-1304			AACS	N2D29	1	
E-1304			AACS	N2D30	1	

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Table A2.2.8. Engineering Measurements
AACS - ATTITUDE AND ARTICULATION CONTROL SUBSYSTEM

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS	COMM POS	NO. OF BITS	FLAGS
E-1304			AACS	N2D31	1	
E-1304			AACS	N2D32	1	
E-1304			AACS	N2D33	1	
E-1304			AACS	N2D34	1	
E-1304			AACS	N2D35	1	
E-1304			AACS	N2D36	1	
E-1304			AACS	N2D37	1	
E-1304			AACS	N2D38	1	
E-1304			AACS	N2D39	1	
E-1304			AACS	N2D40	1	
E-1304			AACS	N2D41	1	
E-1304			AACS	N2D42	1	
E-1304			AACS	N2D43	1	
E-1304			AACS	N2D44	1	
E-1304			AACS	N2D45	1	
E-1304			AACS	N2D46	1	
E-1304			AACS	N2D47	1	
E-1304			AACS	N2D48	1	
E-1304			AACS	N2D49	1	
E-1304			AACS	N2D50	1	
E-1304			AACS	N2D51	1	
E-1304			AACS	N2D52	1	
E-1304			AACS	N2D53	1	
E-1304			AACS	N2D54	1	
E-1304			AACS	N2D55	1	
E-1304			AACS	N2D56	1	

Table A2.2.8. Engineering Measurements
AACS - ATTITUDE AND ARTICULATION CONTROL SUBSYSTEM

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NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS	COMM POS	NO. OF BITS	FLAGS
E-1304				AACS N2D57	1	
E-1304				AACS N2D58	1	
E-1304				AACS N2D59	1	
E-1304				AACS N2D60	1	
E-1304				AACS N2D61	1	
E-1304				AACS N2D62	1	
E-1304				AACS N2D63	1	
E-1304				AACS N2D64	1	
E-1304				AACS N2D65	1	
E-1304				AACS N2D66	1	
E-1304				AACS N2D67	1	
E-1304				AACS N2D68	1	
E-1304				AACS N2D69	1	
E-1304				AACS N2D70	1	
E-1304				AACS N2D71	1	
E-1304				AACS N2D72	1	
E-1304				AACS N2D73	1	
E-1304				AACS N2D74	1	
E-1304				AACS N2D75	1	
E-1304				AACS N2D76	1	
E-1304				AACS N2D77	1	
E-1304				AACS N2D78	1	
E-1304				AACS N2D79	1	
E-1304				AACS N2D80	1	
E-1304				AACS N2D81	1	
E-1304				AACS N2D82	1	

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Table A2.2.8. Engineering Measurements
AACS - ATTITUDE AND ARTICULATION CONTROL SUBSYSTEM

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS	COMM POS	NO. OF BITS	FLAGS
E-1304				AACS N2D83 1		
E-1304				AACS N2D84 1		
E-1304				AACS N2D85 1		
E-1304				AACS N2D86 1		
E-1304				AACS N2D87 1		
E-1304				AACS N2D88 1		
E-1304				AACS N2D89 1		
E-1304				AACS N2D90 1		
E-1305	TCON SPN STATE		AACS	AACS N1D75 1	16	F S
E-1306	TCON UNB STATE		AACS		16	V S
E-1307	TCON POSZ STATE		AACS		16	V S
E-1308	TCON HGA STATE		AACS	AACS N1D88 1	16	F S
E-1309	TCON BAL STATE		AACS		16	V S
E-1310	TCON SUN STATE		AACS	AACS N1D62 1	16	F S
E-1311	TCON LAT STATE		AACS		16	V S
E-1312	TCON PULZ STATE		AACS		16	V S
E-1313	TCON NEGZ STATE		AACS		16	V S
E-1314	LBA 1 COUNT MS WORD		AACS		16	V S
E-1315	LBA 1 COUNT LS WORD		AACS		16	V S
E-1316	LAST POWER CODE TIME (MS)		AACS		16	V S
E-1317	LAST POWER CODE TIME (LS)		AACS	AACS N1D09 1	16	F S
E-1318	LAST FAULT CODE TIME (MS)		AACS		16	V S
E-1319	LAST FAULT CODE TIME (LS)		AACS	AACS N1D51 1	16	F S
E-1320	LAST ALERT CODE TIME (MS)		AACS		16	V S
E-1321	LAST ALERT CODE TIME (LS)		AACS	AACS N1D38 1	16	F S
E-1322	LAST BUS COMMAND TIME (MS)		AACS		16	V S

Table A2.2.8. Engineering Measurements
AACS - ATTITUDE AND ARTICULATION CONTROL SUBSYSTEM

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NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS	COMM POS	NO. OF BITS	FLAGS
E-1323	LAST BUS COMMAND TIME (LS)		AACS	AACS N1D56 1	16	F S
E-1328	TMRO START ADDRESS		AACS	AACS N1D05 1	16	F S
E-1329	TMRO END ADDRESS		AACS	AACS N1D06 1	16	F S
E-1330	ON-LINE BUS PARITY ERROR COUNT		AACS	AACS N1D82 1	16	F S
E-1331	OFF-LINE BUS PARITY ERROR COUNT		AACS	AACS N1D83 1	16	F S
E-1332	ON-LINE MESSAGE PARITY ERROR COUNT		AACS	AACS N1D00 1	16	F S
E-1333	OFF-LINE MESSAGE PARITY ERROR COUNT		AACS	AACS N1D01 1	16	F S
E-1334	ON-LINE ERROR FLAG		AACS	AACS N1D89 1	16	F S
E-1335	OFF-LINE ERROR FLAG		AACS	AACS N1D90 1	16	F S
E-1336	SBA A VIOLATION COUNT		AACS	AACS N1D71 1	16	F S
E-1337	SBA B VIOLATION COUNT		AACS	AACS N1D72 1	16	F S
E-1338	SAS A VIOLATION COUNT		AACS	AACS N1D73 1	16	F S
E-1339	SAS B VIOLATION COUNT		AACS	AACS N1D74 1	16	F S
E-1340	INERTIAL OBSERVER CONVERGENCE COUNTER		AACS	AACS N1D50 1	16	F S
E-1341	INERTIAL OBSERVER GAIN FACTOR		AACS	AACS N1D24 1	16	F S
E-1342	ROTOR ATTITUDE CONVERGENCE COUNTER		AACS	AACS N1D37 1	16	F S
E-1343	ROTOR ATTITUDE GAIN FACTOR		AACS	AACS N1D22 1	16	F S
E-1345	SUN SHUTTER/HIGH VOLTAGE COMMAND		AACS		8	V S
E-1346	SUN SHUTTER/HIGH VOLTAGE STATE		AACS		8	V S
E-1347	ENCODER TIME TAG		AACS		16	V S
E-1348	GYRO TIME TAG		AACS		16	V S
E-1349	THRUSTER ON HEAT		AACS		16	V S
E-1350	THRUSTER OFF HEAT		AACS		16	V S
E-1351	ISOVALVE COMMAND		AACS		16	V S
E-1352	PLUME IMPINGEMENT VIOLATION COUNT		AACS		16	V S
E-1353	RTIO TIME MS WORD		AACS		16	V S

Table A2.2.8. Engineering Measurements
AACS - ATTITUDE AND ARTICULATION CONTROL SUBSYSTEM

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS	COMM POS	NO. OF BITS	FLAGS
E-1354	RTIO TIME LS WORD		AACS		16	V S
E-1359	LBA2 COUNT MS WORD		AACS		16	V S
E-1360	LBA2 COUNT LS WORD		AACS		16	V S
E-1361	FLOOD MODE WORD 1		AACS		16	V S
E-1362	FLOOD MODE WORD 2		AACS		16	V S
E-1363	FLOOD MODE WORD 3		AACS		16	V S
E-1364	FLOOD MODE WORD 4		AACS		16	V S
E-1365	FLOOD MODE WORD 5		AACS		16	V S
E-1366	FLOOD MODE WORD 6		AACS		16	V S
E-1370	FAULT COUNTER		AACS	AACS N1D33 1	16	F S
E-1370				AACS N1D48 1		
E-1371	FAULT FLAG #1		AACS	AACS N1D52 1	16	F S
E-1372	FAULT FLAG #2		AACS	AACS N1D53 1	16	F S
E-1373	FAULT FLAG #3		AACS	AACS N1D54 1	16	F S
E-1374	FAULT PROTECTION STATE 1		AACS	AACS N1D39 1	16	F S
E-1375	FAULT PROTECTION STATE 2		AACS	AACS N1D40 1	16	F S
E-1376	FAULT PROTECTION STATE 3		AACS	AACS N1D41 1	16	F S
E-1377	ROM SAS ENCODER ANGLE				16	ROM
E-1378	ROM SBA ENCODER ANGLE				16	ROM
E-1379	ROM AS DATA				16	ROM
E-1380	ROM SPIN PERIOD				16	ROM
E-1381	ROM AS PULSE WORD				16	ROM
E-1382	ROM MEMORY LOSS ALARM				16	ROM
E-1383	BAD PWR CODE ECHO ONLINE COUNT		AACS		8	V S
E-1384	BAD PWR CODE ECHO OFFLINE COUNT		AACS		16	V S
E-1385	PWR CODE TIMED OUT		AACS		16	V S

Table A2.2.8. Engineering Measurements
AACS - ATTITUDE AND ARTICULATION CONTROL SUBSYSTEM

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NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS	COMM POS	NO. OF BITS	FLAGS
E-1386	POWER CODE RESTARTS		AACS	AACS N1D16 1	16	F S
E-1387	ACCELEROMETER 1 I/O ERROR COUNT		AACS	AACS N1D64 1	16	F S
E-1388	ACCELEROMETER 2 I/O ERROR COUNT		AACS	AACS N1D65 1	16	F S
E-1389	GYRO 2 I/O ERROR COUNT		AACS	AACS N1D42 1	16	F S
E-1390	DEUCE I/O ERROR COUNT		AACS	AACS N1D17 1	16	F S
E-1391	ACE I/O ERROR COUNT		AACS	AACS N1D18 1	16	F S
E-1392	GYRO 1 I/O ERROR COUNT		AACS	AACS N1D34 1	16	F S
E-1393	A/D I/O ERROR COUNT		AACS	AACS N1D80 1	16	F S
E-1394	LAST ALERT CODE		AACS	AACS Z1S00 1	8	F S
E-1395	LAST POWER CODE		AACS	AACS Z2S00 1	8	F S
E-1396	AACS STATUS #1		AACS	AACS Z1D00 1	16	F S
E-1397	AACS STATUS #2		AACS	AACS Z2D00 1	16	F S
E-1398	GYRO 1Y RAW DATA		AACS		16	V S
E-1399	GYRO 1X RAW DATA		AACS		16	V S
E-1400	GYRO 2Y RAW DATA		AACS		16	V S
E-1401	GYRO 2X RAW DATA		AACS		16	V S
E-1402	ACCELEROMETER 1 RAW DATA		AACS		16	V S
E-1403	ACCELEROMETER 2 RAW DATA		AACS		16	V S
E-1404	ACCUMULATED DELTA-V		AACS		16	V S
E-1405	SBA TOTAL TORQUE		AACS		16	V S
E-1406	SAS TOTAL TORQUE		AACS		16	V S
E-1407	SBA POSITION ERROR		AACS		16	V S
E-1408	SAS POSITION ERROR		AACS		16	V S
E-1409	SBA RATE ERROR		AACS		16	V S
E-1410	SAS RATE ERROR		AACS		16	V S
E-1411	SBA FEED-FORWARD TORQUE		AACS		16	V S

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Table A2.2.8. Engineering Measurements
AACS - ATTITUDE AND ARTICULATION CONTROL SUBSYSTEM

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS	COMM POS	NO. OF BITS	FLAGS
E-1412	SAS FEED-FORWARD TORQUE		AACS		16	V S
E-1413	CLOCK CONTROLLER TORQUE		AACS		16	V S
E-1414	CONE CONTROLLER TORQUE		AACS		16	V S
E-1415	ACQUISITION SENSOR E-DATA		AACS	AACS N1D70 1	16	B S
E-1415				AACS N1D85 1		
E-1416	ACQUISITION SENSOR I/G DATA		AACS	AACS N1D86 1	16	B S
E-1417	ROTOR ATTITUDE - RA		AACS	AACS N1D19 1	16	B S
E-1418	ROTOR ATTITUDE - DEC		AACS	AACS N1D20 1	16	B S
E-1419	PLATFORM ATTITUDE - RA		AACS	AACS T2D12 1	16	B S
E-1420	PLATFORM ATTITUDE - DEC		AACS	AACS T3D12 1	16	B S
E-1421	ROTOR ATTITUDE - TWIST		AACS	AACS N1D21 1	16	F S
E-1422	PLATFORM ATTITUDE - TWIST		AACS		16	V S
E-1423	PLATFORM RATE - CONE		AACS		16	V S
E-1424	PLATFORM RATE - CROSS CONE		AACS		16	V S
E-1425	STAR PULSE INTENSITY		AACS		16	V S
E-1426	STAR PULSE TIME		AACS		16	V S
E-1427	STAR SCANNER SAMPLE COUNT		AACS		16	V S
E-1428	SPIN DETECTOR HIGH RATE RAW DATA		AACS		16	V S
E-1429	SPIN DETECTOR LOW RATE RAW DATA		AACS		16	V S
E-1430	SPIN DETECTOR HIGH RATE FILTERED SPIN RATE		AACS	AACS T3D01 1	16	F S
E-1431	SPIN DETECTOR LOW RATE FILTERED SPIN RATE		AACS	AACS T2D01 1	16	F S
E-1432	ACTUAL RANGE 3 CHECKSUM		AACS	AACS N1D68 1	16	F S
E-1433	ACTUAL RANGE 4 CHECKSUM		AACS	AACS N1D69 1	16	F S
E-1434	SEQID RETURN CODE		AACS		8	V S
E-1435	BUFFERED STAR POINTER		AACS		8	V S
E-1436	SEU DETECTION		AACS		16	V S

Table A2.2.8. Engineering Measurements
AACS - ATTITUDE AND ARTICULATION CONTROL SUBSYSTEM

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NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE		TREE POS		COMM POS	NO. OF BITS	FLAGS	
E-1437	TARGET STAR			AACS			8	V	S
E-1438	SEU COUNTER			AACS			16	V	S
E-1439	FAULTPAR			AACS			16	V	S
E-1440	SUN GATE RAW DATA			AACS			16	V	S
E-1441	SEU GATE RAW DATA/LAST VIOLATION			AACS			16	V	S
E-1442	PA THRUSTER DISABLE COUNT			AACS			16	V	S
E-1443	PA INTEG TOGGLE COUNT			AACS			16	V	S
E-1444	FAULT ADDRESS			AACS			16	V	S
E-1472	STAR SCANNER TEMPERATURE	-78. TO 100.	DEG	T1B	76	LLM1B N1D19 1	8	F	T
E-1473	GYRO SENSOR 1 TEMPERATURE	-78. TO 100.	DEG	T2A	56	LLM2A N1D16 1	8	F	T
E-1474	GYRO SENSOR 2 TEMPERATURE	-78. TO 100.	DEG	T2A	6B	LLM2A N1D16 2	8	F	T
E-1475	SPIN BEARING ASSEMBLY MECHANICAL TEMPERATURE 1	-78. TO 100.	DEG	T2A	5A	LLM2A N1D17 1	8	F	T
E-1476	SPIN BEARING ASSEMBLY MECHANICAL TEMPERATURE 2	-78. TO 100.	DEG	T2A	7A	LLM2A N1D17 2	8	F	T
E-1477	LINEAR BOOM ACTUATOR 1 TEMPERATURE	-102. TO 74.	DEG	T1B	68	LLM1B N1D19 2	8	F	T
E-1478	LINEAR BOOM ACTUATOR 2 TEMPERATURE	-102. TO 74.	DEG	T1A	68	LLM1A N1D19 2	8	F	T
E-1479	SCAN ACTUATOR SUBASSEMBLY MECHANICAL TEMPERATURE 1	-102. TO 74.	DEG	T2A	58	LLM2A N1D18 1	8	F	T
E-1480	SCAN ACTUATOR SUBASSEMBLY MECHANICAL TEMPERATURE 2	-102. TO 74.	DEG	T2A	65	LLM2A N1D18 2	8	F	T
E-1481	ACCELEROMETER TRANSDUCER 1 TEMPERATURE	-102. TO 74.	DEG	T2A	6C	LLM2A N1D19 1	8	F	T
E-1482	ACCELEROMETER TRANSDUCER 2 TEMPERATURE	-102. TO 74.	DEG	T2A	75	LLM2A N1D19 2	8	F	T
E-1483	SPIN DETECTOR TEMP	-102. TO 74.	DEG	T1A	7A	LLM1A N1D85 1	8	F	T
E-1485	ACQUISITION SENSOR TEMPERATURE	-102. TO 74.	DEG	T1B	56	LLM1B N1D20 1	8	F	T
E-1486	PA LV/PV VOLT SENSE A	0 TO 3.	VOL	T1A	4E	LLM1A N1D27 1	8	B	A
E-1487	PA LV/PV VOLT SENSE B	0 TO 3.	VOL	T1B	4E	LLM1B N1D27 1	8	B	A

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Table A2.2.8. Engineering Measurements
RPM - RETRO PROPULSION MODULE SUBSYST

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE		TREE POS		COMM POS	NO. OF BITS	FLAGS	
E-1585	HELIUM TANK MANIFOLD PRESSURE, PH1	0. TO 275.	BAR	T1A	1A	LLM1A T1S01 1	8	B	A
E-1586	OXIDIZER TANK 1 PRESSURE, PO1	0. TO 24.	BAR	T1A	20	LLM1A T1S12 1	8	B	A
E-1587	OXIDIZER TANK 2 PRESSURE, PO2	0. TO 24.	BAR	T1B	39	LLM1B T1S12 1	8	B	A
E-1588	FUEL TANK 1 PRESSURE, PF1	0. TO 24.	BAR	T1A	44	LLM1A T2S12 1	8	B	A
E-1589	FUEL TANK 2 PRESSURE, PF2	0. TO 24.	BAR	T1B	20	LLM1B T2S12 1	8	B	A
E-1590	OXIDIZER FEED LINE PRESSURE, PO3	0. TO 24.	BAR	T1B	2C	LLM1B T2S01 1	8	B	A
E-1591	FUEL FEED LINE PRESSURE, PF3	0. TO 24.	BAR	T1A	39	LLM1A T2S01 1	8	B	A
E-1594	400 N ENGINE CHAMBER PRESSURE, PE1	0. TO 27.500	BAR	T1B	49	LLM1B T1S01 1	8	B	A
E-1595	HELIUM TANK #1 TEMPERATURE, TH1	-102. TO 74.	DEG	T1B	51	LLM1B N1D57 1	8	B	T
E-1596	HELIUM TANK #2 TEMPERATURE, TH2	-102. TO 74.	DEG	T1A	71	LLM1A N1D57 1	8	B	T
E-1597	FUEL TANK #1 OUTLET TEMPERATURE, TF1	-102. TO 74.	DEG	T1B	78	LLM1B N1D57 2	8	B	T
E-1598	FUEL TANK #2 OUTLET TEMPERATURE, TF2	-102. TO 74.	DEG	T1A	78	LLM1A N1D57 2	8	B	T
E-1599	OXIDIZER TANK #1 OUTLET TEMPERATURE, TO1	-102. TO 74.	DEG	T1B	74	LLM1B N1D58 1	8	B	T
E-1600	OXIDIZER TANK #2 OUTLET TEMPERATURE, TO2	-102. TO 74.	DEG	T1A	5C	LLM1A N1D58 1	8	B	T
E-1601	-Z1B THRUSTER TEMPERATURE, TT3	-50. TO 586.	DEG	T1B	7C	LLM1B N1D58 2	8	B	T
E-1602	CLUSTER 2 TEMPERATURE 1, TC3	-98. TO 100.	DEG	T1A	6C	LLM1A N1D58 2	8	B	T
E-1603	OXIDIZER TANK 1 INLET TEMPERATURE, TO4	-102. TO 74.	DEG	T1A	74	LLM1A N1D52 1	8	B	T
E-1604	FUEL TANK 1 INLET TEMPERATURE, TF4	-102. TO 74.	DEG	T1B	55	LLM1B N1D52 1	8	B	T
E-1605	-S1B THRUSTER TEMPERATURE, TT11	-50. TO 586.	DEG	T1B	64	LLM1B S2S01 1	8	B	T
E-1606	P2A THRUSTER TEMPERATURE, TT8	-50. TO 586.	DEG	T1A	64	LLM1A S2S00 1	8	B	T
E-1607	P1A THRUSTER TEMPERATURE, TT6	-52. TO 555.	DEG	T1A	53	LLM1A S2S02 1	8	B	T
E-1608	L1B THRUSTER TEMPERATURE, TT7	-52. TO 555.	DEG	T1B	52	LLM1B S2S02 1	8	B	T
E-1609	+S2B THRUSTER TEMPERATURE, TT13	-52. TO 555.	DEG	T1B	63	LLM1B S2S00 1	8	B	T
E-1610	+S2A THRUSTER TEMPERATURE, TT12	-52. TO 555.	DEG	T1A	63	LLM1A S2S01 1	8	B	T
E-1611	400 N INJECTOR TEMPERATURE, TE1	-82. TO 201.	DEG	T1A	73	LLM1A N1D54 1	8	F	T

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Table A2.2.8. Engineering Measurements
RPM - RETRO PROPULSION MODULE SUBSYST

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS	COMM POS	NO. OF BITS	FLAGS	
E-1612	400 N JACKET TEMPERATURE, TE2	-82. TO 201. DEG	T1B 60	LLM1B N1D54 1	8	F	T
E-1613	CLUSTER 1 TEMPERATURE 2, TC2	-225. TO 121. DEG	T1A 51	LLM1A N1D52 2	8	B	T
E-1614	CLUSTER 2 TEMPERATURE 2, TC4	-225. TO 121. DEG	T1B 72	LLM1B N1D65 2	8	B	T
E-1615	-S1A THRUSTER TEMPERATURE, TT10	-50. TO 586. DEG	T1A 62	LLM1A N1D07 1	8	B	T
E-1616	-Z2B THRUSTER TEMPERATURE, TT5	-50. TO 586. DEG	T1B 7B	LLM1B N1D85 1	8	B	T
E-1617	CLUSTER 1 TEMPERATURE 1, TC1	-98. TO 100. DEG	T1B 6A	LLM1B N1D66 2	8	B	T
E-1618	-Z1A THRUSTER TEMPERATURE, TT2	-50. TO 586. DEG	T1A 5A	LLM1A N1D66 2	8	B	T
E-1619	-Z2A THRUSTER TEMPERATURE, TT4	-50. TO 586. DEG	T1A 66	LLM1A N1D66 1	8	B	T
E-1620	L2B THRUSTER TEMPERATURE, TT9	-52. TO 555. DEG	T1B 71	LLM1B N1D52 2	8	B	T

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Table A2.2.8. Engineering Measurements
TEMP - TEMPERATURE CONTROL SUBSYSTEM

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS	COMM POS	NO. OF BITS	FLAGS	
E-1625	PLUME SHIELD TEMPERATURE	-250. TO 580. DEG	T2A 60	LLM2A N1D42 1	8	F	T

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Table A2.2.8. Engineering Measurements
DEV - MECHANICAL DEVICES SUBSYSTEM

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS		COMM POS		NO. OF BITS	FLAGS	
E-0067	PPS/DEV/PRB/UVS STATUS WORD		T2A	01			8	V	D
E-0068	PPS/DEV/PRB STATUS WORD		T2B	01			8	V	D
E-1635	PPS/DEV/SXA STATUS		T1A	02	LLM1A	T2S07 1	8	B	D
E-1636	PPS/DEV/SXA/DDS STATUS		T1B	02	LLM1B	T2S02 1	8	B	D
E-1637	+X RTG BOOM ACTUATOR TEMPERATURE 1	-102. TO 74. DEG	T1B	7D	LLM1B	N1D69 1	8	F	T
E-1638	-X RTG BOOM ACTUATOR TEMPERATURE 1	-102. TO 74. DEG	T1A	69	LLM1A	N1D69 1	8	F	T
E-1639	NUTATION DAMPER TEMPERATURE 1	-102. TO 74. DEG	T1A	58	LLM1A	N1D69 2	8	F	T
E-1640	NUTATION DAMPER TEMPERATURE 2	-102. TO 74. DEG	T1B	54	LLM1B	N1D82 2	8	F	T
E-1641	SCIENCE BOOM ACTUATOR TEMPERATURE 1	-102. TO 74. DEG	T1B	65	LLM1B	N1D69 2	8	F	T
E-1642	SCIENCE BOOM ACTUATOR TEMPERATURE 2	-102. TO 74. DEG	T1A	70	LLM1A	N1D82 2	8	F	T
E-1643	MAG BOOM RATE LIMITER TEMPERATURE 1	-102. TO 74. DEG	T1A	52	LLM1A	N1D81 2	8	F	T
E-1644	MAG BOOM RATE LIMITER TEMPERATURE 2	-102. TO 74. DEG	T1B	58	LLM1B	N1D81 2	8	F	T
E-1645	+X RTG BOOM ACTUATOR TEMPERATUE 2	-102. TO 74. DEG	T1A	65	LLM1A	N1D79 2	8	F	T
E-1646	-X RTG BOOM ACTUATOR TEMPERATURE 2	-102. TO 74. DEG	T1B	75	LLM1B	N1D79 2	8	F	T
E-1647	RELAY ANTENNA DEPLOYMENT MOTOR TEMPERATURE	-102. TO 74. DEG	T2A	69	LLM2A	N1D20 2	8	F	T
E-1648	LGA-2 MOTOR TEMPERATURE 1	-102. TO 74. DEG	T1A	56	LLM1A	N1D83 2	8	F	T
E-1649	LGA-2 MOTOR TEMPERATURE 2	-102. TO 74. DEG	T1B	53	LLM1B	N1D83 2	8	F	T

S/S # 2016

Table A2.2.8. Engineering Measurements
DMS - DATA MEMORY SUBSYSTEM

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE		TREE POS		COMM POS			NO. OF BITS	FLAGS	
E-1650	DMS STATUS DATA A			T1A	0C	LLM1A	S1S06	1	8	F	D
E-1651	DMS STATUS DATA B			T1B	0C	LLM1B	S1S06	1	8	F	D
E-1652	DMS DC MOTOR CURRENT	0. TO 300.	MA	T1A	30	LLM1A	S1S05	1	8	F	A
E-1653	DMS TRANSPORT PRESSURE	0. TO 30.	PSI	T1B	30	LLM1B	T1S05	1	8	F	A

Table A2.2.8. Engineering Measurements
SXA - S/X-BAND ANTENNA SUBSYSTEM

S/S 2017

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS	COMM POS	NO. OF BITS	FLAGS	
E-1635	PPS/DEV/SXA STATUS		T1A 02	LLM1A T2S07 1	8	B	D
E-1636	PPS/DEV/SXA/DDS STATUS		T1B 02	LLM1B T2S02 1	8	B	D
E-1657	HGA MOTOR TEMPERATURE	-225. TO 121. DEG	T1A 60	LLM1A N1D13 1	8	F	T
E-1658	HGA S-BAND FEED TEMPERATURE	-225. TO 121. DEG	T1B 70	LLM1B N1D13 1	8	F	T
E-1659	HGA X-BAND FEED HORN TEMPERATURE	-225. TO 121. DEG	T1B 50	LLM1B N1D13 2	8	F	T
E-1660	LGA BODY TEMPERATURE	-225. TO 121. DEG	T1A 50	LLM1A N1D14 2	8	F	T

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Table A2.2.8. Engineering Measurements
PWS - PLASMA WAVE SUBSYSTEM

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS	COMM POS	NO. OF BITS	FLAGS
E-1675	SEARCH COIL PREAMPLIFIER TEMPERATURE	-94. TO 122. DEG	T1A 75	LLM1A N1D26 2	8	F T
E-1676	MAIN ELECTRONICS TEMPERATURE	-78. TO 100. DEG	T1B 7A	LLM1B N1D26 2	8	F T

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Table A2.2.8. Engineering Measurements
EUV - EXTREME ULTRAVIOLET SUBSYSTEM

S/S # 2024

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE		TREE POS		COMM POS		NO. OF BITS	FLAGS	
E-1680	EUV Analog Multiplexed Housekeeping	0 TO 3	VOLTS	T1A	2C	LLM1A N1D03	2	8	F	A
E-1681	EUV Electronics Temperature	-102 TO 74	DEG	T1A	72	LLM1A N1D03	1	8	F	T

S/S # 2025

Table A2.2.8. Engineering Measurements
EPD - ENERGETIC PARTICLE DETECTOR SUBSYSTEM

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS	COMM POS	NO. OF BITS	FLAGS
E-1690	LEMMS TELESCOPE TEMPERATURE	-102. TO 74. DEG	T1A 59	LLM1A N1D02 2	8	F T
E-1691	CMS TELESCOPE TEMPERATURE	-128. TO 48. DEG	T1A 79	LLM1A N1D02 1	8	F T
E-1692	MAIN ELECTRONICS COVER TEMPERATURE	-102. TO 74. DEG	T1B 69	LLM1B N1D02 2	8	F T
E-1693	MOTOR LEG TEMPERATURE	-128. TO 48. DEG	T1B 5C	LLM1B N1D02 1	8	F T

S/S 2027

Table A2.2.8. Engineering Measurements
PPR - PHOTOPOLARIMETER RADIOMETER SUBSYSTEM

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE		TREE POS		COMM POS		NO. OF BITS	FLAGS	
E-1715	PRISM/DETECTOR ASSEMBLY TEMPERATURE	-102. TO 74.	DEG	T2A	59	LLM2A N1D07	1	8	F	T
E-1716	MAIN ELECTRONICS TEMPERATURE	-102. TO 74.	DEG	T2A	79	LLM2A N1D07	2	8	F	T

S/S 2028

Table A2.2.8. Engineering Measurements
HIC - HEAVY ION COUNTER SUBSYSTEM

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE		TREE POS		COMM POS	NO. OF BITS	FLAGS	
E-1720	HIC ANALOG MULTIPLEXED HOUSEKEEPING	0 TO 3	VOLT	T1B	3D	LLM1B S1S00 1	8	F	A
E-1722	HIC TELESCOPE TEMPERATURE	-102 TO 74	DEG	T1B	62	LLM1B N1D07 1	8	F	T

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Table A2.2.8. Engineering Measurements
DDS - DUST DETECTOR SUBSYSTEM

S/S # 2029

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS	COMM POS	NO. OF BITS	FLAGS
E-1636	PPS/DEV/SXA/DDS STATUS		T1B 02	LLM1B T2S02 1	8	B D
E-1740	SENSOR TEMPERATURE	-102. TO 74. DEG	T1A 5D	LLM1A N1D26 1	8	F T

S/S # 2032

Table A2.2.8. Engineering Measurements
PLS - PLASMA SUBSYSTEM

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE		TREE POS		COMM POS	NO. OF BITS	FLAGS	
E-1750	VELOCITY DISTRIBUTION ANALYZER TEMPERATURE	-102. TO 74.	DEG	T1A	6D	LLM1A N1D15 1	8	F	T
E-1751	COMPOSITION ANALYZER TEMPERATURE	-102. TO 74.	DEG	T1B	5D	LLM1B N1D15 1	8	F	T
E-1752	HIGH VOLTAGE POWER SUPPLY TEMPERATURE	-102. TO 74.	DEG	T1A	7C	LLM1A N1D15 2	8	F	T
E-1753	DATA HANDLING AND CONTROL TEMPERATURE	-102. TO 74.	DEG	T1B	6C	LLM1B N1D15 2	8	F	T

Table A2.2.8. Engineering Measurements
UVS - ULTRAVIOLET SPECTROMETER SUBSYSTEM

S/S 2034

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE		TREE POS	COMM POS	NO. OF BITS	FLAGS	
E-0067	PPS/DEV/PRB/UVS STATUS WORD			T2A 01		8	V	D
E-1790	TC-TRANSDUCER TEMPERATURE	-102. TO 74.	DEG	T2A 64	LLM2A N1D30 2	8	F	T

Table A2.2.8. Engineering Measurements
MAG - MAGNETOMETER SUBSYSTEM

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS	COMM POS	NO. OF BITS	FLAGS	
E-1860	INBOARD SENSOR TEMPERATURE	-87. TO 166. DEG	T1A 55	LLM1A N1D80 1	8	F	T
E-1861	OUTBOARD SENSOR TEMPERATURE	-87. TO 166. DEG	T1B 79	LLM1B N1D80 1	8	F	T
E-1862	ADC TEMPERATURE	-78. TO 100. DEG	T1A 6B	LLM1A N1D80 2	8	F	T
E-1863	ANALOG ELECTRONICS TEMPERATURE	-78. TO 100. DEG	T1B 57	LLM1B N1D80 2	8	F	T

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Table A2.2.8. Engineering Measurements
SSI - SOLID-STATE IMAGING SUBSYSTEM

S/S # 2036

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE		TREE POS		COMM POS		NO. OF BITS	FLAGS	
E-1880	FRONT OPTICS TEMPERATURE	-102. TO 74.	DEG	T2A	68	LLM2A N1D03	1	8	F	T
E-1881	REAR OPTICS TEMPERATURE	-102. TO 74.	DEG	T2A	74	LLM2A N1D03	2	8	F	T
E-1882	RADIATOR PLATE TEMPERATURE	-206. TO 50.	DEG	T2A	71	LLM2A N1D04	1	8	F	T
E-1883	CCD HOUSING TEMPERATURE	-102. TO 74.	DEG	T2A	55	LLM2A N1D04	2	8	F	T
E-1884	REAR ELECTRONICS TEMPERATURE	-102. TO 74.	DEG	T2A	6D	LLM2A N1D05	1	8	F	T
E-1885	FRONT ELECTRONICS TEMPERATURE	-102. TO 74.	DEG	T2A	5D	LLM2A N1D05	2	8	F	T

S/S # 2037

Table A2.2.8. Engineering Measurements
NIMS - NEAR INFRARED MAPPING SPECTROMETER SUBSYSTEM

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE		TREE POS		COMM POS	NO. OF BITS	FLAGS
E-1910	FOCAL PLANE TEMPERATURE	-206. TO 50.	DEG	T2A	51	LLM2A N1D00 1	8	F T
E-1910						LLM2A N1D13 1		
E-1910						LLM2A N1D26 1		
E-1910						LLM2A N1D39 1		
E-1910						LLM2A N1D52 1		
E-1910						LLM2A N1D65 1		
E-1910						LLM2A N1D78 1		
E-1911	RADIATOR SHIELD TEMPERATURE	-206. TO 50.	DEG	T2A	70	LLM2A N1D00 2	8	F T
E-1911						LLM2A N1D13 2		
E-1911						LLM2A N1D26 2		
E-1911						LLM2A N1D39 2		
E-1911						LLM2A N1D52 2		
E-1911						LLM2A N1D65 2		
E-1911						LLM2A N1D78 2		
E-1912	TELESCOPE TEMPERATURE	-206. TO 50.	DEG	T2A	62	LLM2A N1D01 1	8	F T
E-1912						LLM2A N1D14 1		
E-1912						LLM2A N1D27 1		
E-1912						LLM2A N1D40 1		
E-1912						LLM2A N1D53 1		
E-1912						LLM2A N1D66 1		
E-1912						LLM2A N1D79 1		

Table A2.2.8. Engineering Measurements
NIMS - NEAR INFRARED MAPPING SPECTROMETER SUBSYSTEM

S/S # 2037

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE		TREE POS		COMM POS			NO. OF BITS	FLAGS	
E-1913	GRATING MECHANISM TEMPERATURE	-206. TO 50.	DEG	T2A	52	LLM2A	N1D01	2	8	F	T
E-1913						LLM2A	N1D14	2			
E-1913						LLM2A	N1D27	2			
E-1913						LLM2A	N1D40	2			
E-1913						LLM2A	N1D53	2			
E-1913						LLM2A	N1D66	2			
E-1913						LLM2A	N1D79	2			
E-1914	OPTICAL CHOPPER TEMPERATURE	-206. TO 50.	DEG	T2A	63	LLM2A	N1D02	1	8	F	T
E-1914						LLM2A	N1D15	1			
E-1914						LLM2A	N1D28	1			
E-1914						LLM2A	N1D41	1			
E-1914						LLM2A	N1D54	1			
E-1914						LLM2A	N1D67	1			
E-1914						LLM2A	N1D80	1			
E-1915	ELECTRONICS CHASSIS TEMPERATURE	-206. TO 74.	DEG	T2A	54	LLM2A	N1D02	2	8	F	T
E-1915						LLM2A	N1D15	2			
E-1915						LLM2A	N1D28	2			
E-1915						LLM2A	N1D41	2			
E-1915						LLM2A	N1D54	2			
E-1915						LLM2A	N1D67	2			
E-1915						LLM2A	N1D80	2			
E-1916	FLEXPRINT TEMPERATURE	-78. TO 100.	DEG	T2A	5E	LLM2A	N1D56	1	8	F	T

S/S # 2040

Table A2.2.8. Engineering Measurements
SCAS - SCIENCE CALIBRATION SUBSYSTEM

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS	COMM POS	NO. OF BITS	FLAGS
E-1945	RCT-NIMS TEMPERATURE-PT	-102. TO 74. DEG	T2A 7D	LLM2A N1D29 1	8	F T
E-1946	RCT-NIMS TEMPERATURE-NI	-48. TO 47. DEG	T2A 78	LLM2A N1D58 1	8	F T
E-1947	RCT-NIMS REFERENCE R	999.90 TO 999.90TBD	T2A 7C	LLM2A N1D85 1	8	F T
E-1948	PCT TEMPERATURE	-102. TO 74. DEG	T1B 5A	LLM1B N1D14 1	8	F T

Table A2.2.8. Engineering Measurements
XSDC - X/S DOWNCONVERTER SUBSYSTEM

S/S # 2042

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE		TREE POS	COMM POS	NO. OF BITS	FLAGS
E-1980	X/S DC LO VOLTAGE	TBD TO TBD	TBD	T1A 32	LLM1A S1S00 1	8	F A
E-1981	X/S DC POWER SUPPLY VOLTAGE	0. TO 9.	V	T1B 32	LLM1B N1D00 2	8	F A
E-1982	X/S DC TEMPERATURE	-78. TO 100.	DEG	T1B 6B	LLM1B N1D26 1	8	F T

S/S # 2052

Table A2.2.8. Engineering Measurements
RRH - RELAY RADIO HARDWARE SUBSYSTEM

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS	COMM POS	NO. OF BITS	FLAGS
E-1950	PROBE/RRH STATUS WORD 1		T2A 02	LLM2A N1D45 1	8	F D
E-1951	PROBE/RRH STATUS WORD 2		T2B 02	LLM2B N1D45 1	8	F D
E-1960	RRA POSITION POT 1	0. TO 115. DEG	T2A 4B	LLM2A N1D44 1	8	F A
E-1961	RRA POSITION POT 2	0. TO 115. DEG	BDM 00		8	A
E-1965	RECEIVE 1 TEMPERATURE	-78. TO 100. DEG	T2A 76	LLM2A N1D68 1	8	F T
E-1966	RECEIVE 2 TEMPERATURE	-78. TO 100. DEG	T2A 6A	LLM2A N1D33 1	8	F T
E-1967	OSCILLATOR 1 TEMPERATURE	-78. TO 100. DEG	T2A 57	LLM2A N1D68 2	8	F T
E-1968	OSCILLATOR 2 TEMPERATURE	-78. TO 100. DEG	T2A 7E	LLM2A N1D33 2	8	F T

Table A2.2.8. Engineering Measurements
PRB - PROBE SUBSYSTEM

S/S # PRB

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE		TREE POS		COMM POS	NO. OF BITS	FLAGS	
E-0067	PPS/DEV/PRB/UVS STATUS WORD			T2A	01		8	V	D
E-0068	PPS/DEV/PRB STATUS WORD			T2B	01		8	V	D
E-1950	PROBE/RRH STATUS WORD 1			T2A	02	LLM2A N1D45 1	8	F	D
E-1951	PROBE/RRH STATUS WORD 2			T2B	02	LLM2B N1D45 1	8	F	D
E-1952	COMMUNICATIONS SHELF TEMPERATURE	-102. TO 74.	DEG	T2A	50	LLM2A N1D84 1	8	F	T
E-1953	SHELF TEMPERATURE 1	-102. TO 74.	DEG	T2A	61	LLM2A N1D31 1	8	F	T
E-1954	SHELF TEMPERATURE 2	-102. TO 74.	DEG	T2A	72	LLM2A N1D31 2	8	F	T

S/S # 2071

Table A2.2.8. Engineering Measurements
OPE - ORBITER PURGE EQUIPMENT SUBSYSTEM

NUMBER	MEASUREMENT TITLE	ENGINEERING RANGE	TREE POS	COMM POS	NO. OF BITS	FLAGS
E-1970	OPE PRESSURE 1	0. TO 50. PSIA	T2A 31	LLM2A N1D30 1	8	F A

A2.2.14.2 Engineering Formats

There are 5 GLL engineering formats, four of which are on the S/C at any one time. These formats are: anomaly, launch phase I, launch phase II, cruise/encounter/orbital operations, and maneuver/all spin. Each of these formats consists of a fixed area containing measurements common to all formats, and a variable area, containing packets of measurements unique to the specific format. Figure A2.2.12 provides an overview of the engineering commutator structure, showing the fixed and variable areas. The paragraphs that follow indicate the assignment of measurements to specific commutator positions within the fixed and variable areas.

A2.2.14.2.1 Fixed Area Measurement Assignments

Figures A2.2.13 through A2.2.19 indicate the commutator positions assigned to measurements in the fixed area.

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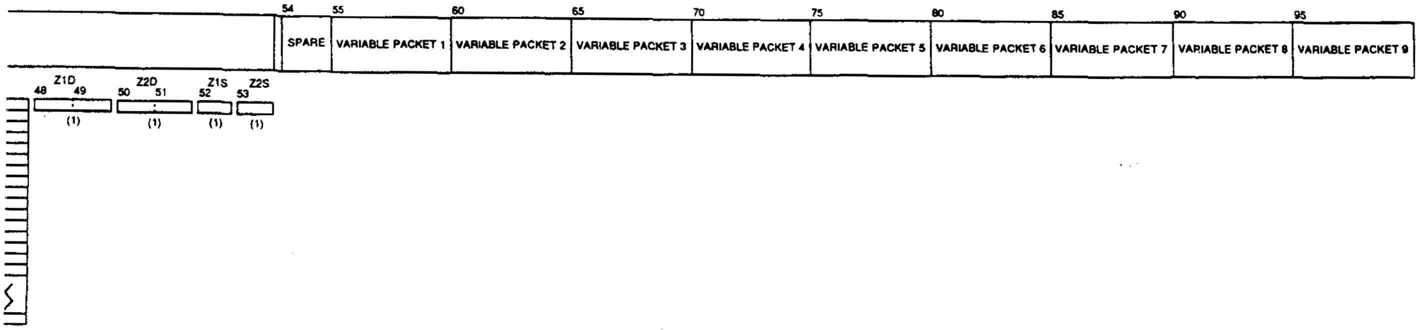
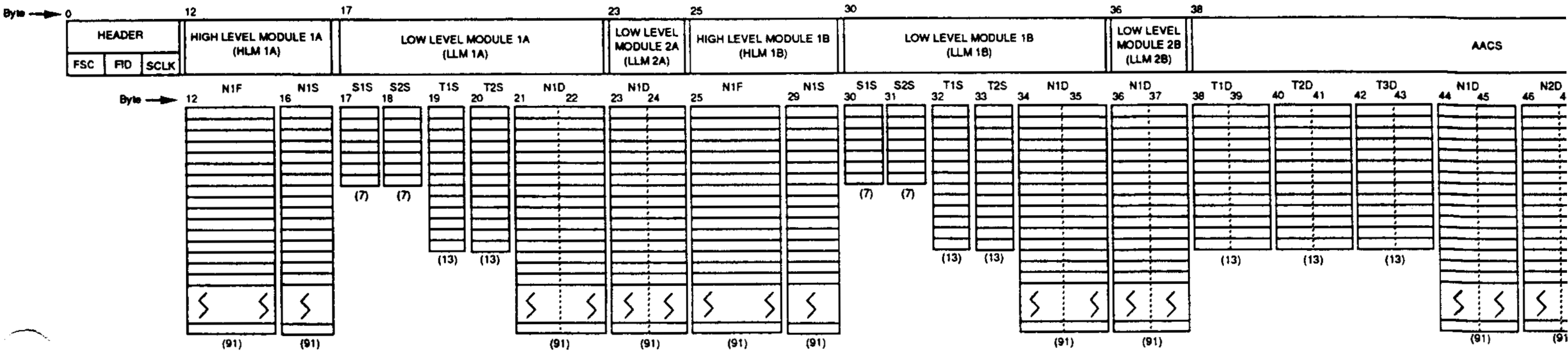


Figure A2.2.12. Engineering Telemetry Commutator Structure



Engineering Telemetry Sampling Period				
Engr. Rate (b/s) \ Sampling Period	1	7	13	91
10	1 Min 20 Sec	9 Min 20 Sec	17 Min 20 Sec	2 Hours 1 Min 20 Sec
40	20 Sec	140 Sec	260 Sec	1820 Sec
1200	2/3 Sec	4-2/3 Sec	8-2/3 Sec	60-2/3 Sec

N1F

00	CDS E-0115			CDS E-0116
01	CDS E-0117			
02	CDS E-0118			
03	CDS E-0119			
04	CDS E-0120			
05	CDS E-0121			
06	CDS E-0122			
07	CDS E-0123			
08	CDS E-0124			
09	CDS E-0125			
10	CDS E-0126			
11	CDS E-0127			
12	CDS E-0128			
13	CDS E-0129			
14	CDS E-0130			
15	CDS E-0131			
16	CDS E-0132			
17	CDS E-0133		CDS E-0134	
18	CDS E-0135		CDS E-0136	
19	CDS E-0137		CDS E-0138	
20	CDS E-0214	CDS E-0215	CDS E-0216	CDS E-0217
21	CDS E-0218	CDS E-0219	CDS E-0220	CDS E-0221
22	CDS E-0141	CDS E-0142	CDS E-0143	CDS E-0144
23	CDS E-0145	CDS E-0146	CDS E-0147	CDS E-0148
24	CDS E-0149	CDS E-0150	CDS E-0151	CDS E-0152
25	CDS E-0153			
26	CDS E-0154			CDS E-0155
27	CDS E-0156			
28	CDS E-0157			CDS E-0158
29	CDS E-0159			
30	CDS E-0160			
31	CDS E-0161	CDS E-0162	CDS E-0163	CDS E-0164
32	CDS E-0165	CDS E-0166	CDS E-0167	CDS E-0168
33	CDS E-0169			CDS E-0170
34	CDS E-0171			
35	CDS E-0172		CDS E-0173	CDS E-0174
36	CDS E-0175	CDS E-0176	CDS E-0177	CDS E-0178
37	CDS E-0179	CDS E-0180	CDS E-0181	CDS E-0182
38	CDS E-0183	CDS E-0184	CDS E-0185	
39	CDS E-0186	CDS E-0187	CDS E-0188	CDS E-0189
40	CDS E-0190			CDS E-0191
41	CDS E-0192	CDS E-0193	CDS E-0194	CDS E-0195
42	CDS E-0196	CDS E-0197	CDS E-0198	CDS E-0199
43	CDS E-0200			CDS E-0201
44	CDS E-0202			CDS E-0203
45	CDS E-0204			CDS E-0205

N1F (cont)

46	CDS E-0206			CDS E-0207
47	CDS E-0208	CDS E-0209	CDS E-0210	
48	CDS E-0213	CDS E-0211		CDS E-0212
49	CDS E-0222		CDS E-0223	
50	CDS E-0224		CDS E-0225	
51	CDS E-0226		CDS E-0227	
52	CDS E-0228		CDS E-0229	
53	CDS E-0230		CDS E-0231	
54	CDS E-0232		CDS E-0233	
55	CDS E-0234		CDS E-0235	
56	CDS E-0236		CDS E-0237	
57	CDS E-0238			
58	CDS E-0239			
59	CDS E-0240			
60	CDS E-0241			
61	CDS E-0242			
62	CDS E-0243			
63	CDS E-0244			
64	CDS E-0245			
65	CDS E-0246			
66	CDS E-0247			
67	CDS E-0248			
68	CDS E-0249			
69	CDS E-0250			
70	CDS E-0251			
71	CDS E-0252			
72	CDS E-0253			
73	CDS E-0254			
74	CDS E-0255			
75	CDS E-0256			
76	CDS E-0257			
77	CDS E-0258			
78	CDS E-0259			
79	CDS E-0260			
80	CDS E-0261			
81	CDS E-0262			
82	CDS E-0263			
83	CDS E-0264			
84	CDS E-0265			
85	CDS E-0266			
86	CDS E-0267			
87	CDS E-0268			
88	CDS E-0269			
89	CDS E-0270			
90	CDS E-0271			

Figure A2.2.13. Fixed Area Measurement Assignment - HLM1A

N1S

	N1S	
00	CDS	E-0272
01	CDS	E-0273
02	CDS	E-0274
03	CDS	E-0275
04	CDS	E-0276
05	CDS	E-0277
06	CDS	E-0278
07	CDS	E-0279
08	CDS	E-0280
09	CDS	E-0281
10	CDS	E-0282
11	CDS	E-0283
12	CDS	E-0284
13	CDS	E-0285
14	CDS	E-0286
15	CDS	E-0287
16	CDS	E-0288
17	CDS	E-0289
18	CDS	E-0290
19	CDS	E-0291
20	CDS	E-0292
21	CDS	E-0293
22	CDS	E-0294
23	CDS	E-0295
24	CDS	E-0296
25	CDS	E-0297
26	CDS	E-0298
27	CDS	E-0299
28	CDS	E-0300
29	CDS	E-0301
30	CDS	E-0302
31	CDS	E-0303
32	CDS	E-0304
33	CDS	E-0305
34	CDS	E-0306
35	CDS	E-0307
36	CDS	E-0308
37	CDS	E-0309
38	CDS	E-0310
39	CDS	E-0311
40	CDS	E-0312
41	CDS	E-0313
42	CDS	E-0314
43	CDS	E-0315
44	CDS	E-0316
45	CDS	E-0317

	N1S (cont)	
46	CDS	E-0318
47	CDS	E-0319
48	CDS	E-0320
49	CDS	E-0321
50	CDS	E-0322
51	CDS	E-0323
52	CDS	E-0324
53	CDS	E-0325
54	CDS	E-0326
55	CDS	E-0327
56	CDS	E-0328
57	CDS	E-0329
58	CDS	E-0330
59	CDS	E-0331
60	CDS	E-0332
61	CDS	E-0333
62	CDS	E-0334
63	CDS	E-0335
64	CDS	E-0336
65	CDS	E-0337
66	CDS	E-0338
67	CDS	E-0339
68	CDS	E-0340
69	CDS	E-0341
70	CDS	E-0342
71	CDS	E-0343
72	CDS	E-0344
73	CDS	E-0345
74	CDS	E-0346
75	CDS	E-0347
76	CDS	E-0348
77	CDS	E-0349
78	CDS	E-0350
79	CDS	E-0351
80	CDS	E-0352
81	CDS	E-0353
82	CDS	E-0354
83	CDS	E-0355
84	CDS	E-0356
85	CDS	E-0357
86	CDS	E-0358
87	CDS	E-0359
88	CDS	E-0360
89	CDS	E-0361
90	CDS	E-0362

Figure A2.2.13. Fixed Area Measurement Assignment - HLM1A (cont)

N1F

00	CDS E-0615			CDS E-0616
01	CDS E-0617			
02	CDS E-0618			
03	CDS E-0619			
04	CDS E-0620			
05	CDS E-0621			
06	CDS E-0622			
07	CDS E-0623			
08	CDS E-0624			
09	CDS E-0625			
10	CDS E-0626			
11	CDS E-0627			
12	CDS E-0628			
13	CDS E-0629			
14	CDS E-0630			
15	CDS E-0631			
16	CDS E-0632			
17	CDS E-0633		CDS E-0634	
18	CDS E-0635		CDS E-0636	
19	CDS E-0637		CDS E-0638	
20	CDS E-0714	CDS E-0715	CDS E-0716	CDS E-0717
21	CDS E-0718	CDS E-0719	CDS E-0720	CDS E-0721
22	CDS E-0641	CDS E-0642	CDS E-0643	CDS E-0644
23	CDS E-0645	CDS E-0646	CDS E-0647	CDS E-0648
24	CDS E-0649	CDS E-0650	CDS E-0651	CDS E-0652
25	CDS E-0653			
26	CDS E-0654			CDS E-0655
27	CDS E-0656			
28	CDS E-0657			CDS E-0658
29	CDS E-0659			
30	CDS E-0660			
31	CDS E-0661	CDS E-0662	CDS E-0663	CDS E-0664
32	CDS E-0665	CDS E-0666	CDS E-0667	CDS E-0668
33	CDS E-0669			CDS E-0670
34	CDS E-0671			
35	CDS E-0672		CDS E-0673	CDS E-0674
36	CDS E-0675	CDS E-0676	CDS E-0677	CDS E-0678
37	CDS E-0679	CDS E-0680	CDS E-0681	CDS E-0682
38	CDS E-0683	CDS E-0684	CDS E-0685	
39	CDS E-0686	CDS E-0687	CDS E-0688	CDS E-0689
40	CDS E-0690			CDS E-0691
41	CDS E-0692	CDS E-0693	CDS E-0694	CDS E-0695
42	CDS E-0696	CDS E-0697	CDS E-0698	CDS E-0699
43	CDS E-0700			CDS E-0701
44	CDS E-0702			CDS E-0703
45	CDS E-0704			CDS E-0705

N1F (cont)

46	CDS E-0706			CDS E-0707
47	CDS E-0708	CDS E-0709	CDS E-0710	
48	CDS E-0713	CDS E-0711		CDS E-0712
49	CDS E-0722		CDS E-0723	
50	CDS E-0724		CDS E-0725	
51	CDS E-0726		CDS E-0727	
52	CDS E-0728		CDS E-0729	
53	CDS E-0730		CDS E-0731	
54	CDS E-0732		CDS E-0733	
55	CDS E-0734		CDS E-0735	
56	CDS E-0736		CDS E-0737	
57	CDS E-0738			
58	CDS E-0739			
59	CDS E-0740			
60	CDS E-0741			
61	CDS E-0742			
62	CDS E-0743			
63	CDS E-0744			
64	CDS E-0745			
65	CDS E-0746			
66	CDS E-0747			
67	CDS E-0748			
68	CDS E-0749			
69	CDS E-0750			
70	CDS E-0751			
71	CDS E-0752			
72	CDS E-0753			
73	CDS E-0754			
74	CDS E-0755			
75	CDS E-0756			
76	CDS E-0757			
77	CDS E-0758			
78	CDS E-0759			
79	CDS E-0760			
80	CDS E-0761			
81	CDS E-0762			
82	CDS E-0763			
83	CDS E-0764			
84	CDS E-0765			
85	CDS E-0766			
86	CDS E-0767			
87	CDS E-0768			
88	CDS E-0769			
89	CDS E-0770			
90	CDS E-0771			

Figure A2.2.14. Fixed Area Measurement Assignment - HLM1B

	N1S	
00	CDS	E-0772
01	CDS	E-0773
02	CDS	E-0774
03	CDS	E-0775
04	CDS	E-0776
05	CDS	E-0777
06	CDS	E-0778
07	CDS	E-0779
08	CDS	E-0780
09	CDS	E-0781
10	CDS	E-0782
11	CDS	E-0783
12	CDS	E-0784
13	CDS	E-0785
14	CDS	E-0786
15	CDS	E-0787
16	CDS	E-0788
17	CDS	E-0789
18	CDS	E-0790
19	CDS	E-0791
20	CDS	E-0792
21	CDS	E-0793
22	CDS	E-0794
23	CDS	E-0795
24	CDS	E-0796
25	CDS	E-0797
26	CDS	E-0798
27	CDS	E-0799
28	CDS	E-0800
29	CDS	E-0801
30	CDS	E-0802
31	CDS	E-0803
32	CDS	E-0804
33	CDS	E-0805
34	CDS	E-0806
35	CDS	E-0807
36	CDS	E-0808
37	CDS	E-0809
38	CDS	E-0810
39	CDS	E-0811
40	CDS	E-0812
41	CDS	E-0813
42	CDS	E-0814
43	CDS	E-0815
44	CDS	E-0816
45	CDS	E-0817

	N1S (cont)	
46	CDS	E-0818
47	CDS	E-0819
48	CDS	E-0820
49	CDS	E-0821
50	CDS	E-0822
51	CDS	E-0823
52	CDS	E-0824
53	CDS	E-0825
54	CDS	E-0826
55	CDS	E-0827
56	CDS	E-0828
57	CDS	E-0829
58	CDS	E-0830
59	CDS	E-0831
60	CDS	E-0832
62	CDS	E-0833
62	CDS	E-0834
63	CDS	E-0835
64	CDS	E-0836
65	CDS	E-0837
66	CDS	E-0838
67	CDS	E-0839
68	CDS	E-0840
69	CDS	E-0841
70	CDS	E-0842
71	CDS	E-0843
72	CDS	E-0844
73	CDS	E-0845
74	CDS	E-0846
75	CDS	E-0847
76	CDS	E-0848
77	CDS	E-0849
78	CDS	E-0850
79	CDS	E-0851
80	CDS	E-0852
81	CDS	E-0853
82	CDS	E-0854
83	CDS	E-0855
84	CDS	E-0856
85	CDS	E-0857
86	CDS	E-0858
87	CDS	E-0859
88	CDS	E-0860
89	CDS	E-0861
90	CDS	E-0862

Figure A2.2.13. Fixed Area Measurement Assignment - HLM1B (cont)

S1S

00	XSDC E-1980
01	PPS E-0105
02	PPS E-0107
03	PPS E-0108
04	RFS E-0024
05	DMS E-1652
06	DMS E-1650

S2S

00	RPM E-1606
01	RPM E-1610
02	RPM E-1607
03	PPS E-0082
04	RFS E-0023
05	PPS E-0109
06	PPS E-0065

T1S

00	CDS E-0423
01	RPM E-1585
02	PPS E-0080
03	PPS E-0097
04	RFS E-0030
05	RFS E-0034
06	MDS E-0055
07	PPS E-0086
08	PPS E-1501
09	RFS E-0032
10	RFS E-0031
11	PPS E-0086
12	RPM E-1586

T2S

00	CDS E-0424
01	RPM E-1591
02	PPS E-0078
03	PPS E-0099
04	RFS E-0039
05	RFS E-0018
06	MDS E-0056
07	DEV E-1635
08	RFS E-0020
09	RFS E-0042
10	PPS E-1505
11	RFS E-0038
12	RPM E-1588

N1D

00	spare	RFS E-0028
01	PPS E-0073	RFS E-0053
02	EPD E-1691	EPD E-1690
03	EUV E-1681	EUV E-1680
04	CDS E-1100	CDS E-1101
05	CDS E-1102	CDS E-1103
06	CDS E-1104	CDS E-1105
07	RPM E-1615	PPS E-0095
08	CDS E-0370	
09	CDS E-0371	CDS E-0372
10	CDS E-0373	CDS E-0374
11	CDS E-0375	
12	CDS E-0376	
13	SXA E-1657	spare
14	spare	SXA E-1660
15	PLS E-1750	PLS E-1752
16	STRU E-0000	STRU E-0002
17	STRU E-0004	STRU E-0006
18	spare	spare
19	spare	AACS E-1478
20	spare	PPS E-0095
21	CDS E-0377	
22	CDS E-0378	
23	CDS E-0379	
24	CDS E-0380	
25	CDS E-0381	
26	DDS E-1740	PWS E-1675
27	AACS E-1486	RFS E-0045
28	CDS E-0365	CDS E-0366
29	CDS E-0367	CDS E-0368

N1D (cont)

30	CDS E-0369	CDS E-0425
31	CDS E-0426	CDS E-0427
32	CDS E-0428	CDS E-0429
33	spare	PPS E-0095
34	CDS E-0382	CDS E-0383
35	CDS E-0384	CDS E-0385
36	CDS E-0386	CDS E-0387
37	CDS E-0388	CDS E-0389
38	CDS E-0390	CDS E-0391
39	CDS E-1106	CDS E-1107
40	CDS E-1108	spare
41	CDS E-1109	CDS E-1110
42	spare	spare
43	spare	PPS E-0090
44	RFS E-1551	RFS E-1557
45	RFS E-1552	spare
46	spare	PPS E-0095
47	CDS E-0392	CDS E-0393
48	CDS E-0394	CDS E-0395
49	CDS E-0396	CDS E-0397
50	CDS E-0398	CDS E-0399
51	CDS E-0400	
52	RPM E-1603	RPM E-1613
53	spare	spare
54	RPM E-1611	spare
55	CDS E-0421	CDS E-0422
56	spare	spare
57	RPM E-1596	RPM E-1598
58	RPM E-1600	RPM E-1602
59	spare	PPS E-0095

N1D (cont)

60	CDS E-0401	CDS E-0402
61	CDS E-0403	
62	CDS E-0404	
63	CDS E-0405	
64	CDS E-0406	
65	PPS E-0089	spare
66	RPM E-1619	RPM E-1618
67	spare	spare
68	spare	spare
69	DEV E-1638	DEV E-1639
70	RFS E-0043	RFS E-0044
71	RFS E-0047	RFS E-0048
72	spare	PPS E-0095
73	CDS E-0407	CDS E-0408
74	CDS E-0409	
75	CDS E-0410	
76	CDS E-0411	
77	CDS E-0412	
78	MDS E-0058	PPS E-0096
79	spare	DEV E-1645
80	MAG E-1860	MAG E-1862
81	spare	DEV E-1643
82	spare	DEV E-1642
83	spare	DEV E-1648
84	PPS E-0069	spare
85	AACS E-1483	PPS E-0095
86	CDS E-0413	CDS E-0414
87	CDS E-0415	
88	CDS E-0416	
89	CDS E-0417	CDSE E-0418
90	CDS E-0419	CDS E-0420

Figure A2.2.15. Fixed Area Measurement Assignment - LLM1A

35244A

35244A

S1S

00	HIC E-1720
01	PPS E-0101
02	PPS E-0102
03	PPS E-0103
04	RFS E-0025
05	PPS E-1500
06	DMS E-1651

S2S

00	RPM E-1609
01	RPM E-1605
02	RPM E-1608
03	PPS E-0083
04	RFS E-0022
05	PPS E-0104
06	PPS E-0066

T1S

00	CDS E-0923
01	RPM E-1594
02	RFS E-0021
03	PPS E-0098
04	RFS E-0026
05	DMS E-1653
06	MDS E-0059
07	RFS E-0019
08	PPS E-1506
09	RFS E-0033
10	RFS E-0027
11	RFS E-0036
12	RPM E-1587

T2S

00	CDS E-0924
01	RPM E-1590
02	DEV E-1636
03	PPS E-0100
04	RFS E-0040
05	RFS E-0041
06	MDS E-0060
07	PPS E-0081
08	PPS E-0087
09	RFS E-0029
10	RFS E-0037
11	RFS E-0035
12	RPM E-1589

N1D

00	PPS E-0088	XSDC E-1981
01	RFS E-0052	PPS E-0075
02	EPD E-1693	EPD E-1692
03	spare	spare
04	CDS E-1120	CDS E-1121
05	CDS E-1122	CDS E-1123
06	CDS E-1124	CDS E-1125
07	HIC E-1722	PPS E-0094
08	CDS E-0870	
09	CDS E-0871	CDS E-0872
10	CDS E-0873	CDS E-0874
11	CDS E-0875	
12	CDS E-0876	
13	SXA E-1658	SXA E-1659
14	SCAS E-1948	spare
15	PLS E-1751	PLS E-1753
16	STRU E-0001	STRU E-0003
17	STRU E-0005	STRU E-0007
18	spare	spare
19	AACS E-1472	AACS E-1477
20	AACS E-1485	PPS E-0094
21	CDS E-0877	
22	CDS E-0878	
23	CDS E-0879	
24	CDS E-0880	
25	CDS E-0881	
26	XSDC E-1982	PWS E-1676
27	AACS E-1487	spare
28	CDS E-0865	CDS E-0866
29	CDS E-0867	CDS E-0868

N1D (cont)

30	CDS E-0869	CDS E-0925
31	CDS E-0926	CDS E-0927
32	CDS E-0928	CDS E-0929
33	spare	PPS E-0094
34	CDS E-0882	CDS E-0883
35	CDS E-0884	CDS E-0885
36	CDS E-0886	CDS E-0887
37	CDS E-0888	CDS E-0889
38	CDS E-0890	CDS E-0891
39	CDS E-1126	CDS E-1127
40	CDS E-1128	spare
41	CDS E-1129	CDS E-1130
42	STRU E-0016	spare
43	spare	PPS E-0091
44	PPS E-0088	spare
45	RFS E-1556	RFS E-1553
46	spare	PPS E-0094
47	CDS E-0892	CDS E-0893
48	CDS E-0894	CDS E-0895
49	CDS E-0896	CDS E-0897
50	CDS E-0898	CDS E-0899
51	CDS E-0900	
52	RPM E-1604	RPM E-1620
53	spare	spare
54	RPM E-1612	spare
55	CDS E-0921	CDS E-0922
56	spare	spare
57	RPM E-1595	RPM E-1597
58	RPM E-1599	RPM E-1601
59	spare	PPS E-0094

N1D (cont)

60	CDS E-0901	CDS E-0902
61	CDS E-0903	
62	CDS E-0904	
63	CDS E-0905	
64	CDS E-0906	
65	PPS E-0106	RPM E-1617
66	PPS E-1507	RPM E-1614
67	spare	spare
68	RFS E-0051	spare
69	DEV E-1637	DEV E-1641
70	RFS E-0050	RFS E-0046
71	STRU E-0017	RFS E-0049
72	spare	PPS E-0094
73	CDS E-0907	CDS E-0908
74	CDS E-0909	
75	CDS E-0910	
76	CDS E-0911	
77	CDS E-0912	
78	MDS E-0062	spare
79	spare	DEV E-1646
80	MAG E-1861	MAG E-1863
81	spare	DEV E-1644
82	spare	DEV E-1640
83	spare	DEV E-1649
84	PPS E-0070	spare
85	RPM E-1616	PPS E-0094
86	CDS E-0913	CDS E-0914
87	CDS E-0915	
88	CDS E-0916	
89	CDS E-0917	CDS E-0918
90	CDS E-0919	CDS E-0920

Figure A2.2.16. Fixed Area Measurement Assignment - LLM1B

N1D

00	NIMS E-1910	NIMS E-1911
01	NIMS E-1912	NIMS E-1913
02	NIMS E-1914	NIMS E-1915
03	SSI E-1880	SSI E-1881
04	SSI E-1882	SSI E-1883
05	SSI E-1884	SSI E-1885
06	CDS E-1136	spare
07	PPR E-1715	PPR E-1716
08	CDS E-0430	
09	CDS E-0431	CDS E-0432
10	CDS E-0433	CDS E-0434
11	CDS E-0435	
12	CDS E-0436	
13	NIMS E-1910	NIMS E-1911
14	NIMS E-1912	NIMS E-1913
15	NIMS E-1914	NIMS E-1915
16	AACS E-1473	AACS E-1474
17	AACS E-1475	AACS E-1476
18	AACS E-1479	AACS E-1480
19	AACS E-1481	AACS E-1482
20	STRU E-0008	DEV E-1647
21	CDS E-0437	
22	CDS E-0438	
23	CDS E-0439	
24	CDS E-0440	
25	CDS E-0441	
26	NIMS E-1910	NIMS E-1911
27	NIMS E-1912	NIMS E-1913
28	NIMS E-1914	NIMS E-1915
29	SCAS E-1945	spare

N1D (cont)

30	OPE E-1970	UVS E-1790
31	PRB E-1953	PRB E-1954
32	STRU E-0010	STRU E-0011
33	RRH E-1966	RRH E-1968
34	CDS E-0442	CDS E-0443
35	CDS E-0444	CDS E-0445
36	CDS E-0446	CDS E-0447
37	CDS E-0448	CDS E-0449
38	CDS E-0450	CDS E-0451
39	NIMS E-1910	NIMS E-1911
40	NIMS E-1912	NIMS E-1913
41	NIMS E-1914	NIMS E-1915
42	TEMP E-1625	STRU E-0009
43	spare	spare
44	RRH E-1960	spare
45	PRB E-1950	spare
46	PPS E-0092	PPS E-0093
47	CDS E-0452	CDS E-0453
48	CDS E-0454	CDS E-0455
49	CDS E-0456	CDS E-0457
50	CDS E-0458	CDS E-0459
51	CDS E-0460	
52	NIMS E-1910	NIMS E-1911
53	NIMS E-1912	NIMS E-1913
54	NIMS E-1914	NIMS E-1915
55	CDS E-0481	CDS E-0482
56	NIMS E-1916	spare
57	spare	spare
58	SCAS E-1946	spare
59	spare	spare

N1D (cont)

60	CDS E-0461	CDS E-0462
61	CDS E-0463	
62	CDS E-0464	
63	CDS E-0465	
64	CDS E-0466	
65	NIMS E-1910	NIMS E-1911
66	NIMS E-1912	NIMS E-1913
67	NIMS E-1914	NIMS E-1915
68	RRH E-1965	RRH E-1967
69	spare	spare
70	spare	spare
71	STRU E-0013	STRU E-0015
72	STRU E-0012	STRU E-0014
73	CDS E-0467	CDS E-0468
74	CDS E-0469	
75	CDS E-0470	
76	CDS E-0471	
77	CDS E-0472	
78	NIMS E-1910	NIMS E-1911
79	NIMS E-1912	NIMS E-1913
80	NIMS E-1914	NIMS E-1915
81	PPS E-0071	PPS E-0072
82	PPS E-0074	PPS E-0076
83	PPS E-0077	PPS E-0079
84	PRB E-1952	spare
85	SCAS E-1947	spare
86	CDS E-0473	CDS E-0474
87	CDS E-0475	
88	CDS E-0476	
89	CDS E-0477	CDS E-0478
90	CDS E-0479	CDS E-0480

Figure A2.2.17. Fixed Area Measurement Assignment - LLM2A

N1D

00	spare	spare
01	spare	spare
02	spare	spare
03	spare	spare
04	spare	spare
05	spare	spare
06	spare	spare
07	spare	spare
08	CDS E-0930	
09	CDS E-0931	CDS E-0932
10	CDS E-0933	CDS E-0934
11	CDS E-0935	
12	CDS E-0936	
13	spare	spare
14	spare	spare
15	spare	spare
16	spare	spare
17	spare	spare
18	spare	spare
19	spare	spare
20	spare	spare
21	CDS E-0937	
22	CDS E-0938	
23	CDS E-0939	
24	CDS E-0940	
25	CDS E-0941	
26	spare	spare
27	spare	spare
28	spare	spare
29	spare	spare

N1D (cont)

30	spare	spare
31	spare	spare
32	spare	spare
33	spare	spare
34	CDS E-0942	CDS E-0943
35	CDS E-0944	CDS E-0945
36	CDS E-0946	CDS E-0947
37	CDS E-0948	CDS E-0949
38	CDS E-0950	CDS E-0951
39	spare	spare
40	spare	spare
41	spare	spare
42	spare	spare
43	spare	spare
44	spare	spare
45	PRB E-1951	spare
46	spare	spare
47	CDS E-0952	CDS E-0953
48	CDS E-0954	CDS E-0955
49	CDS E-0956	CDS E-0957
50	CDS E-0958	CDS E-0959
51	CDS E-0960	
52	spare	spare
53	spare	spare
54	spare	spare
55	CDS E-0981	CDS E-0982
56	spare	spare
57	spare	spare
58	spare	spare
59	spare	spare

N1D (cont)

60	CDS E-0961	CDS E-0962
61	CDS E-0963	
62	CDS E-0964	
63	CDS E-0965	
64	CDS E-0966	
65	spare	spare
66	spare	spare
67	spare	spare
68	spare	spare
69	spare	spare
70	spare	spare
71	spare	spare
72	spare	spare
73	CDS E-0967	CDS E-0968
74	CDS E-0969	
75	CDS E-0970	
76	CDS E-0971	
77	CDS E-0972	
78	spare	spare
79	spare	spare
80	spare	spare
81	spare	spare
82	spare	spare
83	spare	spare
84	spare	spare
85	spare	spare
86	CDS E-0973	CDS E-0974
87	CDS E-0975	
88	CDS E-0976	
89	CDS E-0977	CDS E-0978
90	CDS E-0979	CDS E-0980

Figure A2.2.18. Fixed Area Measurement Assignment - LLM2B

	T1D	T2D	T3D
00	AACS E-1226	AACS E-1227	AACS E-1225
01	AACS E-1265	AACS E-1431	AACS E-1430
02	AACS E-1213	AACS E-1211	AACS E-1257
03	AACS E-1203	AACS E-1222	AACS E-1224
04	AACS E-1219	AACS E-1217	AACS E-1230
05	AACS E-1232	AACS E-1218	AACS E-1231
06	AACS E-1220	AACS E-1204	AACS E-1205
07	AACS E-1233	AACS E-1206	AACS E-1207
08	AACS E-1208	AACS E-1293	AACS E-1215
09	AACS E-1202	AACS E-1294	AACS E-1228
10	AACS E-1203	AACS E-1222	AACS E-1224
11	AACS E-1209	AACS E-1200	AACS E-1242
12	AACS E-1254	AACS E-1419	AACS E-1420

	N1D		N1D (cont)		N1D (cont)
00	AACS E-1332	30	AACS E-1279	60	AACS E-1244
01	AACS E-1333	31	AACS E-1201	61	AACS E-1245
02	AACS E-1267	32	AACS E-1284	62	AACS E-1310
03	AACS E-1266	33	AACS E-1370	63	AACS E-1246
04	AACS E-1239	34	AACS E-1392	64	AACS E-1387
05	AACS E-1328	35	AACS E-1270	65	AACS E-1388
06	AACS E-1329	36	AACS E-1255	66	AACS E-1288
07	AACS E-1295	37	AACS E-1342	67	AACS E-1289
08	AACS E-1248	38	AACS E-1321	68	AACS E-1432
09	AACS E-1317	39	AACS E-1374	69	AACS E-1433
10	AACS E-1212	40	AACS E-1375	70	AACS E-1415
11	AACS E-1249	41	AACS E-1376	71	AACS E-1336
12	AACS E-1250	42	AACS E-1389	72	AACS E-1337
13	AACS E-1251	43	AACS E-1276	73	AACS E-1338
14	AACS E-1252	44	AACS E-1260	74	AACS E-1339
15	AACS E-1253	45	AACS E-1239	75	AACS E-1305
16	AACS E-1386	46	AACS E-1201	76	AACS E-1296
17	AACS E-1390	47	AACS E-1284	77	AACS E-1297
18	AACS E-1391	48	AACS E-1370	78	AACS E-1298
19	AACS E-1417	49	AACS E-1256	79	AACS E-1299
20	AACS E-1418	50	AACS E-1340	80	AACS E-1393
21	AACS E-1421	51	AACS E-1319	81	AACS E-1277
22	AACS E-1343	52	AACS E-1371	82	AACS E-1330
23	AACS E-1210	53	AACS E-1372	83	AACS E-1331
24	AACS E-1341	54	AACS E-1373	84	AACS E-1248
25	AACS E-1261	55	AACS E-1239	85	AACS E-1415
26	AACS E-1262	56	AACS E-1323	86	AACS E-1416
27	AACS E-1263	57	AACS E-1237	87	AACS E-1247
28	AACS E-1264	58	AACS E-1281	88	AACS E-1308
29	AACS E-1278	59	AACS E-1282	89	AACS E-1334
				90	AACS E-1335

Figure A2.2.19. Fixed Area Measurement Assignment - AACS

	N2D		N2D (cont)		N2D (cont)
00	AACS E-1303	30	AACS E-1304	60	AACS E-1304
01	AACS E-1304	31	AACS E-1304	61	AACS E-1304
02	AACS E-1304	32	AACS E-1304	62	AACS E-1304
03	AACS E-1304	33	AACS E-1304	63	AACS E-1304
04	AACS E-1304	34	AACS E-1304	64	AACS E-1304
05	AACS E-1304	35	AACS E-1304	65	AACS E-1304
06	AACS E-1304	36	AACS E-1304	66	AACS E-1304
07	AACS E-1304	37	AACS E-1304	67	AACS E-1304
08	AACS E-1304	38	AACS E-1304	68	AACS E-1304
09	AACS E-1304	39	AACS E-1304	69	AACS E-1304
10	AACS E-1304	40	AACS E-1304	70	AACS E-1304
11	AACS E-1304	41	AACS E-1304	71	AACS E-1304
12	AACS E-1304	42	AACS E-1304	72	AACS E-1304
13	AACS E-1304	43	AACS E-1304	73	AACS E-1304
14	AACS E-1304	44	AACS E-1304	74	AACS E-1304
15	AACS E-1304	45	AACS E-1304	75	AACS E-1304
16	AACS E-1304	46	AACS E-1304	76	AACS E-1304
17	AACS E-1304	47	AACS E-1304	77	AACS E-1304
18	AACS E-1304	48	AACS E-1304	78	AACS E-1304
19	AACS E-1304	49	AACS E-1304	79	AACS E-1304
20	AACS E-1304	50	AACS E-1304	80	AACS E-1304
21	AACS E-1304	51	AACS E-1304	81	AACS E-1304
22	AACS E-1304	52	AACS E-1304	82	AACS E-1304
23	AACS E-1304	53	AACS E-1304	83	AACS E-1304
24	AACS E-1304	54	AACS E-1304	84	AACS E-1304
25	AACS E-1304	55	AACS E-1304	85	AACS E-1304
26	AACS E-1304	56	AACS E-1304	86	AACS E-1304
27	AACS E-1304	57	AACS E-1304	87	AACS E-1304
28	AACS E-1304	58	AACS E-1304	88	AACS E-1304
29	AACS E-1304	59	AACS E-1304	89	AACS E-1304
				90	AACS E-1304

	Z1D		Z2D		Z1S		Z2S
00	AACS E-1396	00	AACS E-1397	00	AACS E-1394	00	AACS E-1395

Figure A2.2.19. Fixed Area Measurement Assignment - AACS (cont)

A2.2.14.2.2 Variable Area Measurement Assignments.

The variable area measurements are grouped into packets, any of which may be placed into one or more engineering formats. The packets are listed in Table A2.2.8A, along with their associated measurements. The actual formats are shown in Figure A2.2.20, and described below.

a. Anomaly Format. The anomaly format shall provide telemetry for enhanced visibility into the spacecraft system for troubleshooting anomalies. This format shall be selectable either by ground command or by an onboard fault detection and correction routine. The format shall be assigned to commutation map identifier 0.

b. Launch Phase I Format (CDS load state). The Launch Phase I format shall provide telemetry from Launch to start of RPM pressurization. Note that GLL-3-120 defines the flight state for this format. 35334

c. Launch Phase II Format (CDS load state). The launch phase II format shall provide telemetry during the RPM pressurization. Note that GLL-3-120 defines the flight state for this format.

d. Cruise/Encounter/Orbital Operations Format. The cruise/encounter/orbital operations format shall provide telemetry from the completion of the RPM pressurization through the end of mission, except for periods when maneuvers occur.

e. Launch Phase III/Maneuver/All Spin Format (CDS load state). The maneuver/all spin format shall provide telemetry during maneuvers and all spin operations, including TCM's. LRS data will be available during these operations. Note that GLL-3-120 defines the flight state for this format. 35334

Table A2.2.8A GLL Variable Telemetry Packet Listing

Packet Source	Packet Name	Measurement #1	Measurement #2	Measurement #3	Measurement #4	Measurement #5
LOW LEVEL MODULE 1A	LLM 1A 01	RFS E-0024	RFS E-0042	RFS E-0031	RFS E-0034	RFS E-0038
	LLM 1A 02	PPS E-0078	PPS E-0086	PPS E-0080	PPS E-1635	PPS E-0090
	LLM 1A 03	spare	RFS E-0023	spare	spare	spare
	LLM 1A 04	RPM E-1585	RPM E-1586	RPM E-1588	RPM E-1591	PPS E-0065
	LLM 1A 05	RPM E-1591	PPS E-0065	RPM E-1585	RPM E-1586	RPM E-1588
	LLM 1A 06	RPM E-1596	RPM E-1598	RPM E-1600	RPM E-1602	RPM E-1603

Packet Source	Packet Name	Measurement #1	Measurement #2	Measurement #3	Measurement #4	Measurement #5
LOW LEVEL MODULE 1B	LLM 1B 01	RFS E-0026	RFS E-0022	RFS E-0027	spare	spare
	LLM 1B 02	PPS E-0083	spare	spare	PPS E-1636	PPS E-0091
	LLM 1B 03	RFS E-0026	RPM E-1594	spare	spare	PPS E-0091
	LLM 1B 04	spare	spare	spare	RPM E-1594	spare
	LLM 1B 05	RPM E-1587	RPM E-1589	RPM E-1590	RPM E-1594	PPS E-0066
	LLM 1B 06	RPM E-1594	PPS E-0066	RPM E-1587	RPM E-1589	RPM E-1590
	LLM 1B 07	RPM E-1595	RPM E-1597	RPM E-1599	RPM E-1601	RPM E-1604

Table A2.2.8A GLL Variable Telemetry Packet Listing

Packet Source	Packet Name	Measurement #1	Measurement #2	Measurement #3	Measurement #4	Measurement #5
LOW LEVEL MODULE 2A	LLM 2A 01	PPS E-0092	PPS E-0093	PPS E-0067	PPS E-1665	spare

Packet Source	Packet Name	Measurement #1	Measurement #2	Measurement #3	Measurement #4	Measurement #5
LOW LEVEL MODULE 2B	LLM 2B 01	spare	spare	PPS E-0068	CTR E-1666	spare

Table A2.2.8A GLL Variable Telemetry Packet Listing (1200 Bps/Launch)

	Packet Source	Packet Name	Measurement #1	Measurement #2	Measurement #3	Measurement #4	Measurement #5
	AACS	AACS 01	AACS E-1398		AACS E-1399		AACS E-1345
		AACS 02	AACS E-1400		AACS E-1401		AACS E-1346
		AACS 03	AACS E-1402		AACS E-1403		AACS E-1345
		AACS 04	AACS E-1404		AACS E-1240		AACS E-1346
		AACS 05	AACS E-1405		AACS E-1406		AACS E-1434
		AACS 06	AACS E-1221		AACS E-1234		AACS E-1383
35334		AACS 07	AACS E-1216		AACS E-1229		AACS E-1437
		AACS 08	AACS E-1226		AACS E-1227		AACS E-1283
35334		AACS 09	AACS E-1429		AACS E-1294		AACSE-1345
		AACS 10	AACS E-1415		AACS E-1416		AACS E-1290
		AACS 11	AACS E-1407		AACS E-1408		AACS E-1345
		AACS 12	AACS E-1409		AACS E-1410		AACS E-1346
		AACS 13	AACS E-1291		AACS E-1292		AACS E-1290
		AACS 14	AACS E-1426		AACS E-1354		AACS E-1434
		AACS 15	AACS E-1425		AACS E-1243		AACS E-1435
35334		AACS 16	AACS E-1417		AACS E-1418		AACS E-1346

Table A2.2.8A GLL Variable Telemetry Packet Listing (10/40 Bps)

Packet Source	Packet Name	Measurement #1	Measurement #2	Measurement #3	Measurement #4	Measurement #5
AACS	AACS 01	AACS E-1398		AACS E-1399		AACS E-1345
	AACS 02	AACS E-1400		AACS E-1401		AACS E-1346
	AACS 03	AACS E-1402		AACS E-1403		AACS E-1427
	AACS 04	AACS E-1404		AACS E-1240		AACS E-1345
	AACS 05	AACS E-1405		AACS E-1406		AACS E-1346
	AACS 06	AACS E-1221		AACS E-1234		AACS E-1383
	AACS 07	AACS E-1417		AACS E-1418		AACS E-1437
	AACS 08	AACS E-1226		AACS E-1227		AACS E-1283
	AACS 09	AACS E-1429		AACS E-1428		AACS E-1454
	AACS 10	AACS E-1200		AACS E-1215		AACS E-1454
	AACS 11	AACS E-1420		AACS E-1419		AACS E-1454
	AACS 12	AACS E-1423		AACS E-1424		AACS E-1290
	AACS 13	AACS E-1291		AACS E-1292		AACS E-1454
	AACS 14	AACS E-1208		AACS E-1354		AACS E-1290
	AACS 15	AACS E-1431		AACS E-1430		AACS E-1290
	AACS 16	AACS E-1303		AACS E-1225		AACS E-1290

Packet Position	1	2	3	4	5	6	7	8	9
Packet Name	LLM1A 01	LLM1A 02	LLM1B 01	spare	spare	AACS 04	AACS 05	AACS 10	AACS 15
Timing Position	A	C	A			N/A	N/A	N/A	N/A

Anomaly Format (Map 0)

Packet Name	LLM1A 01	LLM1A 03	LLM1B 02	LLM2A 01	LLM2B 01	AACS 10	AACS 06	AACS 03	AACS 05
Timing Position	A	C	A	A	A	N/A	N/A	N/A	N/A

Launch Phase I Format (Map 1, during launch phase)
(CDS load state, see GLL-3-120 for flight state) 35334

Packet Name	LLM1A 04	LLM1A 05	LLM1A 06	LLM1B 05	LLM1B 06	LLM1B 07	spare	spare	spare
Timing Position	A	C	B	A	C	B			

Launch Phase II Format (Map 0, during launch phase)
(CDS load state, see GLL-3-120 for flight state) 35334

Packet Name	LLM1A 01	LLM1A 02	LLM1B 01	AACS 11	AACS 12	AACS 13	AACS 14	AACS 15	AACS 05
Timing Position	A	C	A	N/A	N/A	N/A	N/A	N/A	N/A

Cruise/Encounter/Orbital Operations Format (Map 3)

Packet Name	LLM1A 01	LLM1A 03	LLM1B 03	LLM1B 04	LLM2A 01	LLM2B 01	AACS 03	AACS 04	AACS 10
Timing Position	A	C	A	C	A	A	N/A	N/A	N/A

Launch III/Maneuver/All Spin Format (Map 2)
(CDS load state, see GLL-3-120 for flight state) 35334

Figure A2.2.20. GLL Variable Engineering Formats

A2.2.14.3 Digital and Software Measurements

Table A2.2.9 provides detailed data for each digital and software measurement. This data includes, subsystem, title, measurement engineering number, type (digital/software), width in bits, and the interpretation of individual bits.

Table A2.2.9. Digital and Software Bit Definitions (Bit 1 is MSB)

Digital Bit Definitions

RFS/PPS status word 1 E-0018

Bit(s)	Measurement	Contents
1	PPS 2.4 KHz inverter status A	0=main 1=standby
2	PPS PSU-1 pyro arm ind.	0=armed 1=safe
3	+X RTG isolation diode bypass	0=diode bypassed 1=diode unbypassed
4	PPS undervoltage trip ind - A	0=nominal voltage 1=undervoltage
5	RFS S-TWTA pwr output int - A	0=nominal pwr output 1=low pwr output
6	RFS X-exc pwr output int - A	0=nominal pwr output 1=low pwr output
7	RFS X-TWTA pwr output int - A	0=nominal pwr output 1=low pwr output
8	RFS S-exc pwr output int - A	0=nominal pwr output 1=low pwr output

RFS/PPS status word 2 E-0019

Bit(s)	Measurement	Contents
1	PPS 2.4 KHz inverter status B	0=main 1=standby
2	PPS PSU-1 pyro unshort ind.	0=unshorted 1=shorted
3	-X RTG isolation diode bypass	0=diode bypassed 1=diode unbypassed
4	PPS undervoltage trip ind - B	0=nominal voltage 1=undervoltage
5	RFS S-TWTA pwr output int - B	0=nominal pwr output 1=low pwr output
6	RFS X-exc pwr output int - B	0=nominal pwr output 1=low pwr output
7	RFS X-TWTA pwr output int - B	0=nominal pwr output 1=low pwr output
8	RFS S-exc pwr output int - B	0=nominal pwr output 1=low pwr output

Table A2.2.9. Digital and Software Bit Definitions (Bit 1 is MSB)

Bit(s)	Measurement	Contents
1	X-band TWTA power	0=high power 1=low power
2	CS3 CW/CS4 CCW	0=off (HGA) 1=on (LGA-1 OR LGA-2)
3	S-band TWTA-2 on/off	0=off 1=on
4	X-band TWTA-1 on/off	0=off 1=on
5	two-way non-coherent	0=off 1=on
6	X-band exciter number	0=select 2 or X transmitters off 1=select 1
7	S-band ranging	0=on 1=off
8	receiver number	0=receiver 2 1=receiver 1

|1|2|3|4|5|6|7|8| RFS Status Word 1(A) E-0020

Bit(s)	Measurement	Contents
1	USO on/off	0=off 1=on
2	X-band ranging on/off	0=on 1=off
3	CS5 CCW	0=HGA (off) 1=LGA (on)
4	differential one-way ranging	0=off 1=on
5	S-band TWTA-1 on/off	0=off 1=on
6	S-band low/high power	0=high power 1=low power
7	S-band exciter number	0=select 2 or S exciters off 1=select 1
8	X-band TWTA-2 on/off	0=off 1=on

|1|2|3|4|5|6|7|8| RFS Status Word 2(B) E-0021

Table A2.2.9. Digital and Software Bit Definitions (Bit 1 is MSB)

Bit(s)	Measurement	Contents
1	X-band TWTA power	0=high power 1=low power
2	CS3 CW/CS4 CCW	0=off (HGA) 1=on (LGA-1 OR LGA-2)
3	S-band TWTA-2 on/off	0=off 1=on
4	X-band TWTA-1 on/off	0=off 1=on
5	two-way non-coherent	0=off 1=on
6	X-band exciter number	0=select 2 or X transmitters off 1=select 1
7	S-band ranging	0=on 1=off
8	receiver number	0=receiver 2 1=receiver 1

\|1\|2\|3\|4\|5\|6\|7\|8\| RFS Status Word 1(B) E-0052

Bit(s)	Measurement	Contents
1	USO on/off	0=off 1=on
2	X-band ranging on/off	0=on 1=off
3	CS5 CCW	0=HGA (off) 1=LGA (on)
4	differential one-way ranging	0=off 1=on
5	S-band TWTA-1 on/off	0=off 1=on
6	S-band low/high power	0=high power 1=low power
7	S-band exciter number	0=select 2 or S exciters off 1=select 1
8	X-band TWTA-2 on/off	0=off 1=on

\|1\|2\|3\|4\|5\|6\|7\|8\| RFS Status Word 2(A) E-0053

Table A2.2.9. Digital and Software Bit Definitions (Bit 1 is MSB)

Bit(s)	Measurement	Contents
1	X-band output 2	0=off 1=on
2	X-band output 1	0=off 1=on
3	X-band subcarrier frequency	0=low*/very high** 1=high
4	S-band data rate	0=low rate data 1=high rate data
5	S-band subcarrier frequency	0=low 1=high
6	S-band output 2	0=off 1=on
7	S-band output 1	0=off 1=on
8	TMU active unit indicator	0=TMU-B on 1=TMU-A on

|1|2|3|4|5|6|7|8| MDS TMU Status Word 1(A) E-0055

Bit(s)	Measurement	Contents
1	CC select**/TDRS mode*	0=CC-1**/0=off* 1=CC-2**/1=on(no subcarrier)*
2-7	mod index	0=range 0-63 (22.22 mv per DN, 0=350 mv, 63=1750 mv)
8	X/S-band mod index ID	0=S-band mod index 1=X-band mod index

|1|2|3|4|5|6|7|8| MDS TMU Status Word 2(A) E-0056

Bit(s)	Measurement	Contents
1	X-band output 2	0=off 1=on
2	X-band output 1	0=off 1=on
3	X-band subcarrier frequency	0=low*/very high** 1=high
4	S-band data rate	0=low rate data 1=high rate data
5	S-band subcarrier frequency	0=low 1=high
6	S-band output 2	0=off 1=on
7	S-band output 1	0=off 1=on
8	TMU active unit indicator	0=TMU-B on 1=TMU-A on

|1|2|3|4|5|6|7|8| MDS TMU Status Word 1(B) E-0059

* Applies while on TMU-B

** Applies for TMU-A operation (CC-2 operation)

Table A2.2.9. Digital and Software Bit Definitions (Bit 1 is MSB)

MDS TMU Status Word 2(B) E-0060

Bit(s)	Measurement	Contents
1	CC select /TDRS mode TMU-A only/	0=CC-1/0=off* 1=CC-2/1=on (no subcarrier)*
2-7	mod index	0=range 0-63 (22.22 mv per DN, 0=350 mv, 63=1750 mv
8	X/S-band mod index ID	0=S-band mod index 1=X-band mod index

PPS/MDS/CDS status word 1 E-0065

Bit(s)	Measurement	Contents
1	CDS 4.8KHz test/A	0=inhibited 1=enabled
2	PSU-1A enable relays A status	0=enabled 1=disabled
3	spare	
4	PPS pyro amps 1A status (pyro events Mod 2)	0=even # of pyro events since BOM/POR 1=odd # of pyro events since BOM/POR
5	PPS discharge controller use ind.	0=not in use 1=in use
6	MDS TMU active unit ind	0=TMU-A active 1=TMU-B active
7	MDS CDU-A bit sync lock status	0=out of lock 1=in lock
8	MDS CDU-A subcarrier lock status	0=out of lock 1=in lock

PPS/MDS/CDS status word 2 E-0066

Bit(s)	Measurement	Contents
1	CDS 4.8KHz test/B	0=inhibited 1=enabled
2	PSU-1B enable relays B status	0=enabled 1=disabled
3	spare	
4	PPS pyro amps 1B status (pyro events Mod 2)	0=even # of pyro events since BOM/POR 1=odd # of pyro events since BOM/POR
5	spare	
6	MDS CDU active unit ind	0=CDU-A active 1=CDU-B active
7	MDS CDU-B bit sync lock status	0=out of lock 1=in lock
8	MDS CDU-B subcarrier lock status	0=out of lock 1=in lock

* Applies while on TMU-B; for TMU-A operation, adjacent definitions apply.

Table A2.2.9. Digital and Software Bit Definitions (Bit 1 is MSB)

Bit(s)	Measurement	Contents
1	PPS PSU-2A Probe enable relay status	0=enabled 1=disabled
2	DEV scan platform unlatch indicator	0=unlatched 1=stowed
3	PRB PPIU CCB inhibit 1 status	0=enabled 1=safe (see note 2)
4	PPS PSU-2 pyro arm ind.	0=armed 1=safe
5	PRB DCP descent power supply A status	0=off 1=on
6	PPS S/C separation enable relay status	0=enabled 1=disabled
7	S/C - IUS separation indicator A (see note 1 below)	0=separated 1=attached
8	PPS pyro amps 2A status (pyro events MOD 2)	0=even # of pyro events since BOM/POR 1=odd # of pyro events since BOM/POR

1	2	3	4	5	6	7	8

PPS/DEV/PRB/UVS status word E-0067

Bit(s)	Measurement	Contents
1	PPS PSU-2B Probe enable relay status	0=enabled 1=disabled
2	DEV despun elctrnics unlatch indicator	0=unlatched 1=stowed
3	DEV spun-despun separation indicator	0=separated 1=attached
4	PPS PSU-2 pyro unshort ind.	0=unshorted 1=shorted
5	PRB DCP coast power supply status	0=off 1=on
6	PRB PPIU CCB inhibit 2 status	0=enabled 1=safe
7	S/C - IUS separation indicator B (see note 1 below)	0=separated 1=attached
8	PPS pyro amps 2B status (pyro events MOD 2)	0=even # of pyro events since BOM/POR 1=odd # of pyro events since BOM/POR

1	2	3	4	5	6	7	8

PPS/DEV/PRB status word E-0068

Notes: 1) E-0067 (E-0068) bit 7 controls the S/C serial TLM data and clock sent to the STS/IUS "A" ("B") channel. Serial data and clock is enabled (inhibited) when bit 7 is a logical "1" ("0"). See Paragraph 3.4.1.

2) UVS 30VDC power is also inhibited with the safe condition of PRB PPIU CCB inhibit 1 Status.

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Table A2.2.9 Digital and Software Bit Definitions (Bit 1 is MSB)

Bit(s)	Measurement	Contents	
1	LLM-2A MPLO	0=off 1=on	 D
2	LLM-2A Memory Swap	0=off 1=on	 D
3	LLM-2A CC/DC disable	0=off 1=on	 D
4	LLM-2A bus select	0=BUS-2A 1=BUS-2B	 D
5	LLM-2A bus adapter write protect	0=off 1=on	 D
6	LLM-2A write protect 2000-2FFF/6000-6FFF	0=off 1=on	 D
7	LLM-2A write protect 0000-1FFF/4000-5FFF	0=off 1=on	 D
8	spare		

|1|2|3|4|5|6|7|8| HLM1A DESPUN CRC REGISTERS 0-3 (MSB) E-0153

Bit(s)	Measurement	Contents	
1	LLM-2B MPLO	0=off 1=on	 D
2	LLM-2B Memory Swap	0=off 1=on	 D
3	LLM-2B CC/DC disable	0=off 1=on	 D
4	LLM-2B bus select	0=BUS-2A 1=BUS-2B	D
5	LLM-2B bus adapter write protect	0=off 1=on	 D
6	LLM-2B write protect 2000-2FFF/6000-6FFF	0=off 1=on	 D
7	LLM-2B write protect 0000-1FFF/4000-5FFF	0=off 1=on	 D
8	spare		

|1|2|3|4|5|6|7|8| HLM1A DESPUN CRC REGISTERS 0-3 (2SB) E-0153

D=Dependent. This state only occurs when the opposing string's CRC bit is set similarly.

Table A2.2.9 Digital and Software Bit Definitions (Bit 1 is MSB)

HLM1A DESPUN CRC REGISTERS 0-3 (3SB) E-0153

Bit(s)	Measurement	Contents	
1	RRH-2 bus select	0=BUS-2A 1=BUS-2B	D
2	RRH-1 bus select	0=BUS-2A 1=BUS-2B	 D
3	PPR bus select	0=BUS-2A 1=BUS-2B	D
4	NIMS bus select	0=BUS-2A 1=BUS-2B	D
5	SSI bus select	0=BUS-2A 1=BUS-2B	D
6	UVS bus select	0=BUS-2A 1=BUS-2B	D
7-8	spare		

HLM1A DESPUN CRC REGISTERS 0-3 (LSB) E-0153 AND HLM1A DESPUN CRC BANK A E-0155

Bit(s)	Measurement	Contents
1	CRC-2A BA write busy error status	0=no error 1=write attempt when busy
2	CRC-2A BA write protect error status	0=no error 1=error
3	HCD transfer error status	0=no error 1=error
4	HCD POR status	0=no POR 1=one or more PORs
5	BUS-2B POR status	0=no POR 1=one or more PORs
6	BUS-2A POR status	0=no POR 1=one or more PORs
7	CRC-2A BA bus parity error status	0=no error 1=one or more errors, any BA involved
8	CRC-2A BA transaction parity error status	0=no error 1=one or more errors, CRC-2A BA involved

D=Dependent. This state only occurs when the opposing string's CRC bit is set similarly.

Table A2.2.9 Digital and Software Bit Definitions (Bit 1 is MSB)

HLM1A DESPUN CRC REGISTERS 4-6 (MSB) E-0154

Bit(s)	Measurement	Contents	
1	spare		
2	backup MUX control BIT-C	0=reset 1=set	D
3	backup MUX control BIT-B	0=reset 1=set	D
4	backup MUX control BIT-A	0=reset 1=set	D
5	ADC-2A LLM select	0=LLM-2A 1=LLM-2B	D
6	IUS/STS-2B low rate TLM select	0=LLM-2A 1=LLM-2B	D
7	IUS/STS-2A low rate TLM select	0=LLM-2A 1=LLM-2B	D
8	CRC-2A critical enable master	0=off 1=on	

HLM1A DESPUN CRC REGISTERS 4-6 (2SB) E-0154

Bit(s)	Measurement	Contents	
1-4	spare		
5	CRC-2B bus adapter write protect	0=off 1=on	D
6	CRC-2B bus select	0=BUS-2A 1=BUS-2B	D
7	CRC-2A bus adapter write protect	0=off 1=on	D
8	CRC-2A bus select	0=BUS-2A 1=BUS-2B	D

HLM1A DESPUN CRC REGISTERS 4-6 (LSB) E-0154

Bit(s)	Measurement	Contents	
1-2	spare		
3	DESPUN critical enable 5 (spare)	0=reset 1=set	D
4	DESPUN critical enable 4 (spare)	0=reset 1=set	
5	DESPUN critical enable 3 (spare)	0=reset 1=set	
6	DESPUN critical enable 2 (probe umbilical cable cutter enable)	0=reset (ENALBE RESET) 1=set (ENABLE)	D
7	DESPUN critical enable 1 (PPS spare)	0=reset (ENABLE RESET) 1=set (ENABLE)	D
8	DESPUN critical enable 0 (probe release enable)	0=reset (ENABLE RESET) 1=set (ENABLE)	D

D=Dependent. This state only occurs when the opposing string's CRC bit is set similarly.

Table A2.2.9 Digital and Software Bit Definitions (Bit 1 is MSB)

For the bit definition of E-0155, see HLM1A DESPUN CRC REGISTERS 0-3 (LSB) E-0153. Their definitions are identical.

HLM1A DESPUN CRC REGISTERS 0-3 E-0155,

Bit(s)	Measurement	Contents	
1	HLM-1A MPLO	0=off 1=on	D
2	HLM-1A Memory Swap	0=off 1=on	D
3	HLM-1A write protect 5000-5FFF/D000-DFFF	0=off 1=on	D
4	HLM-1A write protect 4000-4FFF/C000-CFFF	0=off 1=on	D
5	HLM-1A write protect 3000-3FFF/B000-BFFF	0=off 1=on	D
6	HLM-1A write protect 2000-2FFF/A000-AFFF	0=off 1=on	D
7	HLM-1A write protect 1000-1FFF/9000-9FFF	0=off 1=on	D
8	HLM-1A write protect 0000-0FFF/8000-8FFF	0=off 1=on	D

|1|2|3|4|5|6|7|8| HLM1A SPUN CRC BANK A REGISTERS 0-3 (MSB) E-0156

Bit(s)	Measurement	Contents	
1	LLM-1A MPLO	0=off 1=on	D
2	LLM-1A Memory Swap	0=off 1=on	D
3	LLM-1A CC/DC disable	0=off 1=on	D
4	LLM-1A bus select	0=BUS-1A 1=BUS-1B	D
5	LLM-1A bus adapter write protect	0=off 1=on	D
6	LLM-1A write protect 2000-2FFF/6000-6FFF	0=off 1=on	D
7	LLM-1A write protect 0000-1FFF/4000-5FFF	0=off 1=on	D
8	spare		

|1|2|3|4|5|6|7|8| HLM1A SPUN CRC BANK A REGISTERS 0-3 (2SB) E-0156

D=Dependent. This state only occurs when the opposing string's CRC bit is set similarly.

Table A2.2.9 Digital and Software Bit Definitions (Bit 1 is MSB)

HLM1A SPUN CRC BANK A REGISTERS 0-3 (3SB) E-0156

Bit(s)	Measurement	Contents	
1	BUM-1A BA-2B write protect 1800-1FFF/5800-5FFF	0=off 1=on	D
2	BUM-1A BA-2B write protect 1000-17FF/5000-57FF	0=off 1=on	D
3	BUM-1A BA-2B write protect 0800-0FFF/4800-4FFF	0=off 1=on	D
4	BUM-1A BA-2B write protect 0000-07FF/4000-47FF	0=off 1=on	D
5	BUM-1A BA-1A write protect 1800-1FFF/5800-5FFF	0=off 1=on	D
6	BUM-1A BA-1A write protect 1000-17FF/5000-57FF	0=off 1=on	D
7	BUM-1A BA-1A write protect 0800-0FFF/4800-4FFF	0=off 1=on	D
8	BUM-1A BA-1A write protect 0000-07FF/4000-47FF	0=off 1=on	D

HLM1A SPUN CRC BANK A REGISTERS 0-3 (LSB) E-0156

Bit(s)	Measurement	Contents	
1	BUM-1A TLM control BA select	0=BA-1A 1=BA-2B	D
2	Golay-1A bus select	0=BUS-1A 1=BUS-1B	D
3	BUM-1A BA-2B bus select	0=BUS-1A 1=BUS-1B	D
4	BUM-1A BA-1A bus select	0=BUS-1A 1=BUS-1B	D
5	BUM-1A memory swap	0=off 1=on	D
6	BUM-1A write protect 3000-37FF/7000-77FF	0=off 1=on	D
7	BUM-1A write protect 2800-2FFF/6800-6FFF	0=off 1=on	D
8	BUM-1A write protect 2000-27FF/6000-67FF	0=off 1=on	D

D=Dependent. This state only occurs when the opposing string's CRC bit is set similarly.

Table A2.2.9 Digital and Software Bit Definitions (Bit 1 is MSB)

Bit(s)	Measurement	Contents	
1-2	spare		
3	4.8 KHZ reference select	0=REF-1A 1=REF-1B	D
4-5	spare		
6	digital engineering serial-binary select	0=LLM-1A 1=LLM-1B	D
7	digital engineering timing chain select	0=TC-1A 1=TC-1B	D
8	CRC-1A critical enable master	0=off 1=on	

|1|2|3|4|5|6|7|8| HLM1A SPUN CRC BANK A REGISTERS 4-6 (MSB) E-0157

Bit(s)	Measurement	Contents	
1	HCD POR test control	0=off 1=on	D
2-4	spare		
5	HCD-1A override-3	0=on 1=off	
6	HCD-1A override-2	0=off 1=on	
7	HCD-1A override-1	0=off 1=on	
8	HCD-1B disable	0=off 1=on	

|1|2|3|4|5|6|7|8| HLM1A SPUN CRC BANK A REGISTERS 4-6 (2SB) E-0157

Bit(s)	Measurement	Contents	
1-2	spare		
3	spun critical enable 5 (spare)	0=reset 1=set	
4	spun critical enable 4 (RPN 2nd isolate and bypass enable)	0=reset (ENABLE RESET) 1=set (ENABLE)	D
5	spun critical enable 3 (AACS 400N engine enable)	0=reset (ENABLE) 1=set (DISABLE)	D
6	spun critical enable 2 (AACS memory B write protect)	0=reset 1=set	*
7	spun critical enable 1 (AACS memory A write protect)	0=reset 1=set	*
8	spun critical enable 0 (spare)	0=reset 1=set	

|1|2|3|4|5|6|7|8| HLM1A SPUN CRC BANK A REGISTERS 4-6 (LSB) E-0157

D=Dependent. This state only occurs when the opposing string's CRC bit is set similarly.

* Write Protect disabled when opposing string is set similarly;
  Write Protect enabled when opposing string is set differently.

Table A2.2.9 Digital and Software Bit Definitions (Bit 1 is HSB)

For the bit definition of E-0158, see HLM1A SPUN CRC STATUS WORD E-0168. Their definitions are identical.

HLM1A DESPUN CRC BANK A E-0158

Bit(s)	Measurement	Contents	
1	HLM-1B MPLO	0=off 1=on	D
2	HLM-1B memory swap	0=off 1=on	D
3	HLM-1B write protect 5000-5FFF/D000-DFFF	0=off 1=on	D
4	HLM-1B write protect 4000-4FFF/C000-CFFF	0=off 1=on	D
5	HLM-1B write protect 3000-3FFF/B000-BFFF	0=off 1=on	D
6	HLM-1B write protect 2000-2FFF/A000-AFFF	0=off 1=on	D
7	HLM-1B write protect 1000-1FFF/9000-9FFF	0=off 1=on	D
8	HLM-1B write protect 0000-0FFF/8000-8FFF	0=off 1=on	D

|1|2|3|4|5|6|7|8| HLM1A SPUN CRC BANK B REGISTERS 0-3 (MSB) E-0159

1	LLM-1B MPLO	0=off 1=on	D
3	LLM-1B memory swap	0=off 1=on	D
3	LLM-1B CC/DC disable	0=off 1=on	D
4	LLM-1B bus select	0=BUS-1A 1=BUS-1B	D
5	LLM-1B bus adapter write protect	0=off 1=on	D
6	LLM-1B write protect 2000-2FFF/6000-6FFF	0=off 1=on	D
7	LLM-1B write protect 0000-1FFF/4000-5FFF	0=off 1=on	D
8	spare		

|1|2|3|4|5|6|7|8| HLM1A SPUN CRC BANK B REGISTERS 0-3 (2SB) E-0159

D=Dependent. This state only occurs when the opposing string's CRC bit is set similarly.

Table A2.2.9 Digital and Software Bit Definitions (Bit 1 is MSB)

HLM1A SPUN CRC BANK B REGISTERS 0-3 (3SB) E-0159

Bit(s)	Measurement	Contents	
1	BUM-1B BA-2A write protect 1800-1FFF/5800-5FFF	0=off 1=on	D
2	BUM-1B BA-2A write protect 1000-17FF/5000-57FF	0=off 1=on	D
3	BUM-1B BA-2A write protect 0800-0FFF/4800-4FFF	0=off 1=on	D
4	BUM-1B BA-2A write protect 0000-07FF/4000-47FF	0=off 1=on	D
5	BUM-1B BA-1B write protect 1800-1FFF/5800-5FFF	0=off 1=on	D
6	BUM-1B BA-1B write protect 1000-17FF/5000-57FF	0=off 1=on	D
7	BUM-1B BA-1B write protect 0800-0FFF/4800-4FFF	0=off 1=on	D
8	BUM-1B BA-1B write protect 0000-07FF/4000-47FF	0=off 1=on	D

HLM1A SPUN CRC BANK B REGISTERS 0-3 (LSB) E-0159

Bit(s)	Measurement	Contents	
1	BUM-1B TLM control BA select	0=BA-1B 1=BA-2A	D
2	Golay-1B bus select	0=BUS-1A 1=BUS-1B	D
3	BUM-1B BA-2A bus select	0=BUS-1A 1=BUS-1B	D
4	BUM-1B BA-1B bus select	0=BUS-1A 1=BUS-1B	D
5	BUM-1B memory swap	0=off 1=on	D
6	BUM-1B write protect 3000-37FF/7000-77FF	0=off 1=on	D
7	BUM-1B write protect 2800-2FFF/6800-6FFF	0=off 1=on	D
8	BUM-1B write protect 2000-27FF/6000-67FF	0=off 1=on	D

D=Dependent. This state only occurs when the opposing string's CRC bit is set similarly.

Table A2.2.9 Digital and Software Bit Definitions (Bit 1 is MSB)

Bit(s)	Measurement	Contents	
1	HIC/EUV bus select	0=BUS-1A 1=BUS-1B	D
2	DDS bus select	0=BUS-1A 1=BUS-1B	D
3	EPD bus select	0=BUS-1A 1=BUS-1B	D
4	PWS bus select	0=BUS-1A 1=BUS-1B	D
5	MAG bus select	0=BUS-1A 1=BUS-1B	D
6	PLS bus select	0=BUS-1A 1=BUS-1B	D
7	AACS-B bus select	0=BUS-1A 1=BUS-1B	D
8	AACS-A bus select	0=BUS-1A 1=BUS-1B	D

|1|2|3|4|5|6|7|8| HLM1A SPUN CRC BANK B REGISTERS 4-7 (MSB) E-0160

Bit(s)	Measurement	Contents	
1	DBUM-1B Memory Swap	0=off 1=on	D
2	DBUM-1A Memory Swap	0=off 1=on	D
3	spare		
4	HCD POR test select	0=PC-1A 1=PC-1B	D
5	timing chain manual select control	0=off 1=on	D
6	timing chain manual select	0=TC-1A 1=TC-1B	D
7	POR fault override control	0=off 1=on	D
8	POR fault override select	0=PC-1A 1=PC-1B	D

|1|2|3|4|5|6|7|8| HLM1A SPUN CRC BANK B REGISTERS 4-7 (2SB) E-0160

D=Dependent. This state only occurs when the opposing string's CRC bit is set similarly.

Table A2.2.9 Digital and Software Bit Definitions (Bit 1 is MSB)

HLM1A SPUN CRC BANK B REGISTERS 4-7 (3SB) E-0160

Bit(s)	Measurement	Contents	
1	spare		
2-3	hi rate TLM mod TMU-1B select	00=LLM-1A (Note 1) 01=BUM-1A 10=LLM-1B 11=BUM-1B	
4	low rate TLM mod TMU-1B select	0=LLM-1A 1=LLM-1B	D
5	spare	.	
6-7	hi rate TLM mod TMU-1A select	00=LLM-1A (Note 2) 01=BUM-1A 10=LLM-1B 11=BUM-1B	
8	low rate TLM mod TMU-1A select	0=LLM-1A 1=LLM-1B	D

HLM1A SPUN CRC BANK B REGISTERS 4-7 (LSB) E-0160

Bit(s)	Measurement	Contents	
1	spare DBUM select	0=DBUM-1A 1=DBUM-1B	D
2	DBUM-1B bus select	0=BUS-1A 1=BUS-1B	D
3	DMS DBUM select	0=DBUM-1A 1=DBUM-1B	D
4	DBUM-1A bus select	0=BUS-1A 1=BUS-1B	D
5	CRC-1B bus adapter write protect	0=off 1=on	D
6	CRC-1B bus select	0=BUS-1A 1=BUS-1B	D
7	CRC-1A bus adapter write protect	0=off 1=on	D
8	CRC-1A bus select	0=BUS-1A 1=BUS-1B	D

D=Dependent. This state only occurs when the opposing string's CRC bit is set similarly.

Note 1 - The LLM's are the source only if both strings' CRC bit 3 are reset (logical 0).
The A string (LLM or Bum) is the source only if both strings' CRC bit 2 are reset (logical 0).

Note 2 - The LLM's are the source only if both strings' CRC bit 7 are reset (logical 0).
The B string (LLM or BUM) is the source only if both strings' CRC bit 6 are set (logical 1).

Table A2.2.9 Digital and Software Bit Definitions (Bit 1 is MSB)

Bit(s)	Measurement	Contents
1-6	HCD-1A command message number	6 LSBs of cmd message sent to HCD-1A
7	HCD-1A start word bit error status	0=error-free start word 1=error in start word
8	HCD-1A message status	0=accepted 1=rejected

|1|2|3|4|5|6|7|8| HLM1A HCD COMMAND SUMMARY WORD E-0161

Bit(s)	Measurement	Contents
1-8	HCD-1A messages received and accepted counter	increments by one for each message accepted by HCD-1A (MOD 256)

|1|2|3|4|5|6|7|8| HLM1A MSG RCVD AND ACCEPTED COUNTER E-0162

Bit(s)	Measurement	Contents
1-8	HCD-1A messages received and rejected counter	increments by one for each message rejected by HCD-1A (MOD 256)

|1|2|3|4|5|6|7|8| HLM1A MSG RCVD AND RJCTD COUNTER E-0163

Bit(s)	Measurement	Contents
1-8	HCD-1A command frame errors detected counter	increments by one for each command frame detected with errors by HCD-1A (MOD 256)

|1|2|3|4|5|6|7|8| HLM1A CMD FRAME ERRORS DETECTED COUNTER E-0164

Bit(s)	Measurement	Contents
1-8	HCD-1A data frame errors corrected counter	increments by one for each data frame corrected by HCD-1A (MOD 256)

|1|2|3|4|5|6|7|8| HLM1A DATA FRAME ERRORS CORRECTED COUNTER E-0165

Bit(s)	Measurement	Contents
1-8	HCD-1A data frame errors uncorrectable counter	increments by one for each erroneous data frame uncorrectable by HCD-1A (MOD 256)

|1|2|3|4|5|6|7|8| HLM1A DATA FRAME ERRORS UNCORRECTABLE COUNTER E-0166

Bit(s)	Measurement	Contents
1-8	HCD-1A lock changes counter	increments by one for each lock change provided to HCD-1A (MOD 256)

|1|2|3|4|5|6|7|8| HLM1A LOCK CHANGES COUNTER E-0167

Table A2.2.9 Digital and Software Bit Definitions (Bit 1 is MSB)

Bit(s)	Measurement	Contents
1	CRC-1A BA write busy error status	0=no error 1=write attempt when busy
2	CRC-1A BA write protect error status	0=no error 1=error
3	CRC-1A command block write attempt	0=no attempt 1=one or more attempts
4	CRC-1A power converter/ HCD POR status	0=no POR 1=one or more PORs
5	spare	
6	multiple frame CMD with zero data frames	0=no error 1=one or more errors
7	CRC-1A BA BUS parity error status	0=no error 1=one or more errors, any BA involved
8	CRC-1A BA transaction parity error status	0=no error 1=one or more errors, CRC-1A BA involved

|1|2|3|4|5|6|7|8| HLM1A SPUN CRC STATUS WORD E-0168 AND
HLM1A SPUN CRC BANK A E-0158

Table A2.2.9 Digital and Software Bit Definitions (Bit 1 is MSB)

Bit(s)	Measurement	Contents
1	BUS-1A overrun status	0=no overrun 1=overrun error, bus transaction in process at RTI
2	HLM-1A self-test failure status	0=pass 1=fail
3	HLM-1A keep-alive POR status	0=no KAPOR 1=one or more KAPORs with memory loss
4	HLM-1A POR status	0=no POR 1=one or more PORs, any power failure
5	HLM-1A microprocessor sync-idle status	0=in sync 1=out of sync (1802 vs BIS) /idle lockup
6	HLM-1A BA bus parity error status - despun mux	0=no error 1=one or more errors, any BA involved (DESPUN MUX)
7	HLM-1A BA bus parity error status	0=no error 1=one or more errors, any BA involved(BC or SPUN MUX)
8	HLM-1A BA transaction parity error status	0=no error 1=one or more errors, HLM-1A BA involved

\|1\|2\|3\|4\|5\|6\|7\|8\| HLM1A ERROR WORDS IOSL 0-1-2 (MSB) E-0169

Table A2.2.9 Digital and Software Bit Definitions (Bit 1 is MSB)

Bit(s)	Measurement	Contents
1	HCD parity error status	0=no error 1=one or more parity errors from HCD to HLM-1A
2	HLM-1A microprocessor memory read parity error status	0=no error 1=one or more parity errors when memory read by processor
3	HLM-1A BA memory read parity error status	0=no error 1=one or more parity errors when memory read by BA
4	HLM-1A bus controller memory read parity error status	0=no error 1=one or more parity errors when memory read by BC
5	HLM-1A microprocessor lockout status	0=no MPLO 1=MPLO
6	HLM-1A BA write protect error status	0=no error 1=write attempt by BA into protected memory
7	HLM-1A microprocessor write protect error status	0=no error 1=write attempt by processor into protected memory
8	HCD write protect error status	0=no error 1=write attempt by HCD into protected memory

|1|2|3|4|5|6|7|8| HLM1A ERROR WORDS IOSL 0-1-2 (2SB) E-0169

Bit(s)	Measurement	Contents
1-2	grounded spare	
3	PLL-1B timing chain select status	0=timing chain A 1=timing chain B
4	PLL-1A timing chain select status	0=timing chain A 1=timing chain B
5-6	grounded spare	
7	phase locked loop 1B POR status	0=no POR 1=one or more PORs
8	phase locked loop 1A POR status	0=no POR 1=one or more PORs

|1|2|3|4|5|6|7|8| HLM1A ERROR WORDS IOSL 0-1-2 (LSB) E-0169

Table A2.2.9 Digital and Software Bit Definitions (Bit 1 is MSB)

Bit(s)	Measurement	Contents
1-3	spare	
4	BUM-1A POR status	0=no POR 1=one or more PORs
5	BUM-1A BA 2B bus parity error status	0=no error 1=one or more parity errors involving any BA on its bus
6	BUM-1A BA 2B transaction parity error status	0=no error 1=one or more parity errors involving BUM-1A's BA-2B
7	BUM-1A BA 1A bus parity error status	0=no error 1=one or more parity errors involving any BA on its bus
8	BUM-1A BA 1A transaction parity error status	0=no error 1=one or more parity errors involving BUM-1A's BA-1A

|1|2|3|4|5|6|7|8| HLM1A BUM ERROR WORDS (MSB) E-0171

Bit(s)	Measurement	Contents
1	BUM-1A telemetry formatter memory read parity error status	0=no error 1=one or more parity errors when memory read by formatter
2	BUM-1A telemetry sequencer memory read parity error status	0=no error 1=one or more parity errors when memory read by sequencer
3	BUM-1A BA-2B memory read parity error status	0=no error 1=one or more parity errors when memory read by BA-2B
4	BUM-1A BA-1A memory read parity error status	0=no error 1=one or more parity errors when memory read by BA-1A
5-6	spare	
7	BUM-1A BA-2B write protect error status	0=no error 1=write attempt by BA-2B into protected memory
8	BUM-1A BA-1A write protect error status	0=no error 1=write attempt by BA-1A into protected memory

|1|2|3|4|5|6|7|8| HLM1A BUM ERROR WORDS (2SB) E-0171

Table A2.2.9 Digital and Software Bit Definitions (Bit 1 is MSB)

HLM1A BUM ERROR WORDS (3SB) E-0171

Bit(s)	Measurement	Contents
1-3	spare	
4	BUM-1B POR status	0=no POR 1=one or more PORs
5	BUM-1B BA-2A bus parity error status	0=no error 1=one or more parity errors involving any BA on its bus
6	BUM-1B BA-2A transaction parity error status	0=no error 1=one or more parity errors involving BUM-1B's BA 2
7	BUM-1B BA-1B bus parity error status	0=no error 1=one or more parity errors involving any BA on its bus
8	BUM-1B BA-1B transaction parity error status	0=no error 1=one or more parity errors involving BUM-1B's BA 1

HLM1A BUM ERROR WORDS (LSB) E-0171

Bit(s)	Measurement	Contents
1	BUM-1B telemetry formatter memory read parity error status	0=no error 1=one or more parity errors when memory read by formatter
2	BUM-1B telemetry sequencer memory read parity error status	0=no error 1=one or more parity errors when memory read by sequencer
3	BUM-1B BA-2A memory read parity error status	0=no error 1=one or more parity errors when memory read by BA-2A
4	BUM-1B BA-1B memory read parity error status	0=no error 1=one or more parity errors when memory read by BA-1B
5-6	spare	
7	BUM-1B BA-2A write protect error status	0=no error 1=write attempt by BA-2A into protected memory
8	BUM-1B BA-1B write protect error status	0=no error 1=write attempt by BA-1B into protected memory

Table A2.2.9 Digital and Software Bit Definitions (Bit 1 is MSB)

Bit(s)	Measurement	Contents
1	DMS illegal command status	0=no illegal command 1=illegal cmd (not per DMS CMD dictionary)
2	DBUM-1A sequencer output memory read parity error status	0=no error 1=one or more parity errors when memory read by DBUM sequencer
3	DBUM-1A formatter memory read parity error status	0=no error 1=one or more parity errors when memory read by formatter
4	DBUM-1A bus adapter memory read parity error status	0=no error 1=one or more parity errors when memory read by BA
5	DMS tape direction status	0=forward 1=reverse
6	DBUM-1A POR status	0=no POR 1=one or more PORs
7	DBUM-1A bus adapter bus parity error status	0=no error 1=one or more parity errors involving any BA
8	DBUM-1A BA transaction parity error status	0=no error 1=one or more parity errors involving DBUM-1A BA

|1|2|3|4|5|6|7|8| HLM1A DBUM ERROR WORDS (MSB) E-0172

Table A2.2.9 Digital and Software Bit Definitions (Bit 1 is MSB)

Bit(s)	Measurement	Contents
1	DMS illegal command status	0=no illegal command 1=illegal cmd (not per DMS CMD dictionary)
2	DBUM-1B sequencer output memory read parity error status	0=no error 1=one or more parity errors when memory read by DBUM sequencer
3	DBUM-1B formatter memory read parity error status	0=no error 1=one or more parity errors when memory read by formatter
4	DBUM-1B bus adapter memory read parity error status	0=no error 1=one or more parity errors when memory read by BA
5	DMS tape direction status	0=forward 1=reverse
6	DBUM-1B POR status	0=no POR 1=one or more PORs
7	DBUM-1B bus adapter bus parity error status	0=no error 1=one or more parity errors involving any BA
8	DBUM-1B BA transaction parity error status	0=no error 1=one or more parity errors involving DBUM-1B BA

|1|2|3|4|5|6|7|8| HLM1A DBUM ERROR WORDS (LSB) E-0172

Bit(s)	Measurement	Contents
1	LLM-1A microprocessor lockout status	0=no MPLO 1=MPLO
2	LLM-1A self-test failure status	0=pass 1=fail
3	CC/DC in-process status	0=no cmd beginning execute 1=cmd beginning execute
4	LLM-1A POR status	0=no POR 1=one or more PORs, any power failure
5	LLM-1A microprocessor sync-idle error status	0=in sync 1=out of sync (1802 vs BIS) /idle lockup
6	CC/DC hardware buffer full status	0=empty 1=full
7	LLM-1A BA bus parity error status	0=no error 1=one or more errors, any BA involved
8	LLM-1A BA transaction parity error status	0=no error 1=one or more errors, LLM-1A BA involved

|1|2|3|4|5|6|7|8| LLM1A ERROR WORD-1 IOSL-0 E-0413

Table A2.2.9 Digital and Software Bit Definitions (Bit 1 is MSB)

LLM1A ERROR WORD-2 IOSL-1 E-0414

Bit(s)	Measurement	Contents
1	LLM-1A TLM port memory read parity error status	0=no error 1=one or more parity errors when memory read by TLM port
2	LLM-1A microprocessor memory read parity error status	0=no error 1=one or more parity errors when memory read by processor
3	LLM-1A BA memory read parity error status	0=no error 1=one or more parity errors when memory read by BA
4	engineering control port memory read parity error status	0=no error 1=one or more parity errors when memory read by engr. control port
5	CC/DC error status	0=overwrite not attempted 1=attempt to load CC/DC H/W buffer when already full
6	LLM-1A BA write protect error status	0=no error 1=write attempt by BA into protected memory, or I/O selects
7	LLM-1A microprocessor write protect error status	0=no error 1=write attempt by processor into protected memory
8	engineering data port write protect error status	0=no error 1=write attempt by engr. data port into protected memory

LLM1A DMS TAPE POSITION ESTIMATE (MSB) E-0423

Bit(s)	Measurement	Contents
1	DMS BOT/EOT status	0=BOT 1=EOT
2	DMS leader/tape status	0=on tape 1=on leader
3-8	tic count status (6 MSB)	6 MSBs of the 14 bit tic count

LLM1A DMS TAPE POSITION ESTIMATE (LSB) E-0424

Bit(s)	Measurement	Contents
1-8	tic count status (8 LSB)	8 LSBs of the 14 bit tic count

Table A2.2.9 Digital and Software Bit Definitions (Bit 1 is MSB)

Bit(s)	Measurement	Contents
1	LLM-2A microprocessor lockout status	0=no MPLO 1=MPLO
2	LLM-2A self-test failure status	0=pass 1=fail
3	CC/DC in-process status	0=no cmd beginning execute 1=cmd beginning execute
4	LLM-2A POR status	0=no POR 1=one or more PORs, any power failure
5	LLM-2A microprocessor sync-idle error status	0=in sync 1=out of sync (1802 vs BIS) /idle lockup
6	CC/DC hardware buffer full status	0=empty 1=full
7	LLM-2A BA bus parity error status	0=no error 1=one or more errors, any BA involved
8	LLM-2A BA transaction parity error status	0=no error 1=one or more errors, LLM-2A BA involved

|1|2|3|4|5|6|7|8| LLM2A ERROR WORD-1 IOSL-0 E-0473

Table A2.2.9 Digital and Software Bit Definitions (Bit 1 is MSB)

Bit(s)	Measurement	Contents
1	LLM-2A TLM port memory read parity error status	0=no error 1=one or more parity errors when memory read by TLM port
2	LLM-2A microprocessor memory read parity error status	0=no error 1=one or more parity errors when memory read by processor
3	LLM-2A BA memory read parity error status	0=no error 1=one or more parity errors when memory read by BA
4	engineering control port memory read parity error status	0=no error 1=one or more parity errors when memory read by engr. control port
5	CC/DC error status	0=overwrite not attempted 1=attempt to load CC/DC H/W buffer when already full
6	LLM-2A BA write protect error status	0=no error 1=write attempt by BA into protected memory, or I/O selects
7	LLM-2A microprocessor write protect error status	0=no error 1=write attempt by processor into protected memory
8	engineering data port write protect error status	0=no error 1=write attempt by engr. data port into protected memory

|1|2|3|4|5|6|7|8| LLM2A ERROR WORD-2 IOSL-1 E-0474

Table A2.2.9 Digital and Software Bit Definitions (Bit 1 is MSB)

Bit(s)	Measurement	Contents	
1	LLM-2A MPLO	0=off 1=on	D
2	LLM-2A memory swap	0=off 1=on	D
3	LLM-2A CC/DC disable	0=off 1=on	D
4	LLM-2A bus select	0=BUS-2A 1=BUS-2B	D
5	LLM-2A bus adapter write protect	0=off 1=on	D
6	LLM-2A write protect 2000-2FFF/6000-6FFF	0=off 1=on	D
7	LLM-2A write protect 0000-1FFF/4000-5FFF	0=off 1=on	D
8	spare		

|1|2|3|4|5|6|7|8| HLM1B DESPUN CRC REGISTERS 0-3 (MSB) E-0653

Bit(s)	Measurement	Contents	
1	LLM-2B MPLO	0=off 1=on	D
2	LLM-2B Memory Swap	0=off 1=on	D
3	LLM-2B CC/DC disable	0=off 1=on	D
4	LLM-2B bus select	0=BUS-2A 1=BUS-2B	D
5	LLM-2B bus adapter write protect	0=off 1=on	D
6	LLM-2B write protect 2000-2FFF/6000-6FFF	0=off 1=on	D
7	LLM-2B write protect 0000-1FFF/4000-5FFF	0=off 1=on	D
3	spare		

|1|2|3|4|5|6|7|8| HLM1B DESPUN CRC REGISTERS 0-3 (2SB) E-0653

D=Dependant. This state only occurs when the opposing string's CRC bit is set similarly

Table A2.2.9 Digital and Software Bit Definitions (Bit 1 is MSB)

Bit(s)	Measurement	Contents	
1	RRH-2 bus select	0=BUS-2A 1=BUS-2B	D
2	RRH-1 bus select	0=BUS-2A 1=BUS-2B	 D
3	PPR bus select	0=BUS-2A 1=BUS-2B	D
4	NIMS bus select	0=BUS-2A 1=BUS-2B	D
5	SSI bus select	0=BUS-2A 1=BUS-2B	D
6	UVS bus select	0=BUS-2A 1=BUS-2B	D
7-8	spare		

|1|2|3|4|5|6|7|8| HLM1B DESPUN CRC REGISTERS 0-3 (3SB) E-0653

Bit(s)	Measurement	Contents
1	CRC-2B BA write busy error status	0=no error 1=write attempt when busy
2	CRC-2B BA write protect error status	0=no error 1=error
3	HCD transfer error status	0=no error 1=error
4	HCD POR status	0=no POR 1=one or more PORs
5	BUS-2B POR status	0=no POR 1=one or more PORs
6	BUS-2A POR status	0=no POR 1=one or more PORs
7	CRC-2B BA bus parity error status	0=no error 1=one or more errors, any BA involved
8	CRC-2B BA transaction parity error status	0=no error 1=one or more errors, CRC-2B BA involved

|1|2|3|4|5|6|7|8| HLM1B DESPUN CRC REGISTERS 0-3 (LSB) E-0653 AND
HLM1B DESPUN CRC BANK B E-0655

D=Dependant. This state only occurs when the opposing string's CRC bit is set similarly

Table A2.2.9 Digital and Software Bit Definitions (Bit 1 is MSB)

HLM1B DESPUN CRC REGISTERS 4-6 (MSB) E-0654

Bit(s)	Measurement	Contents	
1	spare		
2	backup MUX control BIT-C	0=reset 1=set	D
3	backup MUX control BIT-B	0=reset 1=set	D
4	backup MUX control BIT-A	0=reset 1=set	D
5	ADC-2A LLM select	0=LLM-2A 1=LLM-2B	D
6	IUS/STS-2B low rate TLM select	0=LLM-2A 1=LLM-2B	D
7	IUS/STS-2A low rate TLM select	0=LLM-2A 1=LLM-2B	D
8	CRC-2B critical enable master	0=off 1=on	

HLM1B DESPUN CRC REGISTERS 4-6 (2SB) E-0654

Bit(s)	Measurement	Contents	
1-4	spare		
5	CRC-2B bus adapter write protect	0=off 1=on	D
6	CRC-2B bus select	0=BUS-2A 1=BUS-2B	D
7	CRC-2A bus adapter write protect	0=off 1=on	D
8	CRC-2A bus select	0=BUS-2A 1=BUS-2B	D

HLM1B DESPUN CRC REGISTERS 4-6 (LSB) E-0654

Bit(s)	Measurement	Contents	
1-2	spare		
3	DESPUN critical enable 5 (spare)	0=reset 1=set	D
4	DESPUN critical enable 4 (spare)	0=reset 1=set	
5	DESPUN critical enable 3 (spare)	0=reset 1=set	
6	DESPUN critical enable 2 (probe umbilical cable cutter enable)	0=reset (ENABLE RESET) 1=set (ENABLE)	D
7	DESPUN critical enable 1 (PPS spare)	0=reset (ENABLE RESET) 1=set (ENABLE)	D
8	DESPUN critical enable 0 (probe release enable)	0=reset (ENABLE RESET) 1=set (ENABLE)	D

D=Dependant. This state only occurs when the opposing string's CRC bit is set similarly

Table A2.2.9 Digital and Software Bit Definitions (Bit 1 is MSB)

For the definition of E-0655, see HLM1B DESPUN CRC REGISTERS 0-3 (LSB) E-0653. Their definitions are identical.

HLM1B DESPUN CRC BANK B E-0655

Bit(s)	Measurement	Contents	
1	HLM-1A MPLO	0=off 1=on	D
2	HLM-1A memory swap	0=off 1=on	D
3	HLM-1A write protect 5000-5FFF/D000-DFFF	0=off 1=on	D
4	HLM-1A write protect 4000-4FFF/C000-CFFF	0=off 1=on	D
5	HLM-1A write protect 3000-3FFF/B000-BFFF	0=off 1=on	D
6	HLM-1A write protect 2000-2FFF/A000-AFFF	0=off 1=on	D
7	HLM-1A write protect 1000-1FFF/9000-9FFF	0=off 1=on	D
8	HLM-1A write protect 0000-0FFF/8000-8FFF	0=off 1=on	D

|1|2|3|4|5|6|7|8| HLM1B SPUN CRC BANK A REGISTERS 0-3 (MSB) E-0656

Bit(s)	Measurement	Contents	
1	LLM-1A MPLO	0=off 1=on	D
2	LLM-1A memory swap	0=off 1=on	D
3	LLM-1A CC/DC disable	0=off 1=on	D
4	LLM-1A bus select	0=BUS-1A 1=BUS-1B	D
5	LLM-1A bus adapter write protect	0=off 1=on	D
6	LLM-1A write protect 2000-2FFF/6000-6FFF	0=off 1=on	D
7	LLM-1A write protect 1000-1FFF/4000-5FFF	0=off 1=on	D
8	spare		

|1|2|3|4|5|6|7|8| HLM1B SPUN CRC BANK A REGISTERS 0-3 (2SB) E-0656

D=Dependant. This state only occurs when the opposing string's CRC bit is set similarly

Table A2.2.9 Digital and Software Bit Definitions (Bit 1 is MSB)

Bit(s)	Measurement	Contents	
1	BUM-1A BA-2B write protect 1800-1FFF/5800-5FFF	0=off 1=on	D
2	BUM-1A BA-2B write protect 1000-17FF/5000-57FF	0=off 1=on	D
3	BUM-1A BA-2B write protect 0800-0FFF/4800-4FFF	0=off 1=on	D
4	BUM-1A BA-2B write protect 0000-07FF/4000-47FF	0=off 1=on	D
5	BUM-1A BA-1A write protect 1800-1FFF/5800-5FFF	0=off 1=on	D
6	BUM-1A BA-1A write protect 1000-17FF/5000-57FF	0=off 1=on	D
7	BUM-1A BA-1A write protect 0800-0FFF/4800-4FFF	0=off 1=on	D
8	BUM-1A BA-1A write protect 0000-07FF/4000-47FF	0=off 1=on	D

|1|2|3|4|5|6|7|8| HLM1B SPUN CRC BANK A REGISTERS 0-3 (3SB) E-0656

Bit(s)	Measurement	Contents	
1	BUM-1A TLM control BA select	0=BA-1A 1=BA-2B	D
2	Golay-1A bus select	0=BUS-1A 1=BUS-1B	D
3	BUM-1A BA-2B bus select	0=BUS-1A 1=BUS-1B	D
4	BUM-1A BA-1A bus select	0=BUS-1A 1=BUS-1B	D
5	BUM-1A memory swap	0=off 1=on	D
6	BUM-1A write protect 3000-37FF/7000-7FFF	0=off 1=on	D
7	BUM-1A write protect 2800-2FFF/6800-6FFF	0=off 1=on	D
8	BUM-1A write protect 2000-27FF/6000-67FF	0=off 1=on	D

|1|2|3|4|5|6|7|8| HLM1B SPUN CRC BANK A REGISTERS 0-3 (LSB) E-0656

D=Dependant. This state only occurs when the opposing string's CRC bit is set similarly

Table A2.2.9 Digital and Software Bit Definitions (Bit 1 is MSB)

Bit(s)	Measurement	Contents	
1-2	spare		
3	4.8 KHZ reference select	0=REF-1A 1=REF-1B	D
4-5	spare		
6	digital engineering serial-binary select	0=LLM-1A 1=LLM-1B	D
7	digital engineering timing chain select	0=TC-1A 1=TC-1B	D
8	CRC-1B critical enable master	0=off 1=on	

|1|2|3|4|5|6|7|8| HLM1B SPUN CRC BANK A REGISTERS 4-6 (MSB) E-0657

Bit(s)	Measurement	Contents	
1	HCD POR test control	0=off 1=on	D
2-4	spare		
5	HCD-1B override-3	0=on 1=off	
6	HCD-1B override-2	0=off 1=on	
7	HCD-1B override-1	0=off 1=on	
8	HCD-1A disable	0=off 1=on	

|1|2|3|4|5|6|7|8| HLM1B SPUN CRC BANK A REGISTERS 4-6 (2SB) E-0657

Bit(s)	Measurement	Contents	
1-2	spare		
3	spun critical enable 5 (spare)	0=reset 1=set	
4	spun critical enable 4 (RPN 2nd isolate and bypass enable)	0=reset (ENABLE RESET) 1=set (ENABLE)	D
5	spun critical enable 3 (AACS 400N engine enable)	0=reset (ENABLE) 1=set (DISABLE)	D
6	spun critical enable 2 (AACS memory B write protect)	0=reset 1=set	
7	spun critical enable 1 (AACS memory A write protect)	0=reset 1=set	*
8	spun critical enable 0 (spare)	0=reset 1=set	

|1|2|3|4|5|6|7|8| HLM1B SPUN CRC BANK A REGISTERS 4-6 (LSB) E-0657

* Write protect disabled when opposing string is set similarly; write protect enabled when opposing string is set differently.

D=Dependant. This state only occurs when the opposing string's CRC bit is set similarly

Table A2.2.9 Digital and Software Bit Definitions (Bit 1 is MSB)

For the bit definition of E-0658, see HLM1B SPUN CRC STATUS WORD E-0668. Their definitions are identical.

HLM1B SPUN CRC BANK B E-0658

Bit(s)	Measurement	Contents	
1	HLM-1B MPLO	0=off 1=on	D
2	HLM-1B memory swap	0=off 1=on	D
3	HLM-1B write protect 5000-5FFF/D000-DFFF	0=off 1=on	D
4	HLM-1B write protect 4000-4FFF/C000-CFFF	0=off 1=on	D
5	HLM-1B write protect 3000-3FFF/B000-BFFF	0=off 1=on	D
6	HLM-1B write protect 2000-2FFF/A000-AFFF	0=off 1=on	D
7	HLM-1B write protect 1000-1FFF/9000-9FFF	0=off 1=on	D
8	HLM-1B write protect 0000-0FFF/8000-8FFF	0=off 1=on	D

|1|2|3|4|5|6|7|8| HLM1B SPUN CRC BANK B REGISTERS 0-3 (MSB) E-0659

Bit(s)	Measurement	Contents	
1	LLM-1B MPLO	0=off 1=on	D
2	LLM-1B memory swap	0=off 1=on	D
3	LLM-1B CC/DC disable	0=off 1=on	D
4	LLM-1B bus select	0=BUS-1A 1=BUS-1B	D
5	LLM-1B bus adapter write protect	0=off 1=on	D
6	LLM-1B write protect 2000-2FFF/6000-6FFF	0=off 1=on	D
7	LLM-1B write protect 0000-1FFF/4000-5FFF	0=off 1=on	D
8	spare		

|1|2|3|4|5|6|7|8| HLM1B SPUN CRC BANK B REGISTERS 0-3 (2SB) E-0659

D=Dependant. This state only occurs when the opposing string's CRC bit is set similarly

Table A2.2.9 Digital and Software Bit Definitions (Bit 1 is MSB)

HLM1B SPUN CRC BANK B REGISTERS 0-3 (3SB) E-0659

Bit(s)	Measurement	Contents	
1	BUM-1B BA-2A write protect 1800-1FFF/5800-5FFF	0=off 1=on	D
2	BUM-1B BA-2A write protect 1000-17FF/5000-57FF	0=off 1=on	D
3	BUM-1B BA-2A write protect 0800-0FFF/4800-4FFF	0=off 1=on	D
4	BUM-1B BA-2A write protect 0000-07FF/4000-47FF	0=off 1=on	D
5	BUM-1B BA-1B write protect 1800-1FFF/5800-5FFF	0=off 1=on	D
6	BUM-1B BA-1B write protect 1000-17FF/5000-57FF	0=off 1=on	D
7	BUM-1B BA-1B write protect 0800-0FFF/4800-4FFF	0=off 1=on	D
8	BUM-1B BA-1B write protect 0000-07FF/4000-47FF	0=off 1=on	D

|1|2|3|4|5|6|7|8| HLM1B SPUN CRC BANK B REGISTERS 0-3 (3SB) E-0659

Bit(s)	Measurement	Contents	
1	BUM-1B TLM control BA select	0=BA-1B 1=BA-2A	D
2	Golay-1B bus select	0=BUS-1A 1=BUS-1B	D
3	BUM-1B BA-2A bus select	0=BUS-1A 1=BUS-1B	D
4	BUM-1B BA-1B bus select	0=BUS-1A 1=BUS-1B	D
5	BUM-1B memory swap	0=off 1=on	D
6	BUM-1B write protect 3000-37FF/7000-7FFF	0=off 1=on	D
7	BUM-1B write protect 2800-2FFF/6800-6FFF	0=off 1=on	D
8	BUM-1B write protect 2000-27FF/6000-67FF	0=off 1=on	D

|1|2|3|4|5|6|7|8| HLM1B SPUN CRC BANK B REGISTERS 0-3 (LSB) E-0659

D=Dependant. This state only occurs when the opposing string's CRC bit is set similarly

Table A2.2.9 Digital and Software Bit Definitions (Bit 1 is MSB)

Bit(s)	Measurement	Contents	
1	HIC/EUV bus select	0=BUS-1A	D
		1=BUS-1B	
2	DDS bus select	0=BUS-1A	D
		1=BUS-1B	
3	EPD bus select	0=BUS-1A	D
		1=BUS-1B	
4	PWS bus select	0=BUS-1A	D
		1=BUS-1B	
5	MAG bus select	0=BUS-1A	D
		1=BUS-1B	
6	PLS bus select	0=BUS-1A	D
		1=BUS-1B	
7	AACS-B bus select	0=BUS-1A	D
		1=BUS-1B	
8	AACS-A bus select	0=BUS-1A	
		1=BUS-1B	D

|1|2|3|4|5|6|7|8| HLM1B SPUN CRC BANK B REGISTERS 4-7 (MSB) E-0660

Bit(s)	Measurement	Contents	
1	DBUM-1B memory swap	0=OFF	
		1=ON	D
2	DBUM-1A memory swap	0=OFF	
		1=ON	D
3	spare		
4	HCD POR test select	0=PC-1A	
		1=PC-1B	D
5	timing chain manual select control	0=off	
		1=on	D
6	timing chain manual select	0=TC-1A	
		1=TC-1B	D
7	POR fault override control	0=off	
		1=on	D
8	POR fault override select	0=PC-1A	
		1=PC-1B	D

|1|2|3|4|5|6|7|8| HLM1B SPUN CRC BANK B REGISTERS 4-7 (2SB) E-0660

D=Dependant. This state only occurs when the opposing string's CRC bit is set similarly

Table A2.2.9 Digital and Software Bit Definitions (Bit 1 is MSB)

Bit(s)	Measurement	Contents	
1	spare		
2-3	hi rate TLM mod TMU-1B	00=LLM-1A (Note 1)	
	select	01=BUM-1A	
		10=LLM-1B	
		11=BUM-1B	
4	low rate TLM mod TMU-1B	0=LLM-1A	D
	select	1=LLM-1B	
5	spare		
6-7	hi rate TLM mod TMU-1A	00=LLM-1A (Note 2)	
	select	01=BUM-1A	
		10=LLM-1B	
		11=BUM-1B	
8	low rate TLM mod TMU-1A	0=LLM-1A	
	select	1=LLM-1B	D

|1|2|3|4|5|6|7|8| HLM1B SPUN CRC BANK B REGISTERS 4-7 (3SB) E-0660

Bit(s)	Measurement	Contents	
1	spare DBUM select	0=DBUM-1A	D
		1=DBUM-1B	
2	DBUM-1B bus select	0=BUS-1A	D
		1=BUS-1B	
3	DMS DBUM select	0=DBUM-1A	
		1=DBUM-1B	D
4	DBUM-1A bus select	0=BUS-1A	
		1=BUS-1B	D
5	CRC-1B bus adapter write	0=off	
	protect	1=on	D
6	CRC-1B bus select	0=BUS-1A	D
		1=BUS-1B	
7	CRC-1A bus adapter write	0=off	
	protect	1=on	D
8	CRC-1A bus select	0=BUS-1A	
		1=BUS-1B	D

|1|2|3|4|5|6|7|8| HLM1B SPUN CRC BANK B REGISTERS 4-7 (LSB) E-0660

D=Dependant. This state only occurs when the opposing string's CRC bit is set similarly

Note 1 - The LLM's are the source only if both strings' CRC bit 3 are reset (logical 0).
The A string (LLM or BUM is the source only if both strings' CRC bit 2 are reset (logical 0).

Note 2 - The LLM's are the source only if both strings' CRC bit 7 are reset (logical 0).
The B string (LLM or BUM) is the source only if both strings' CRC bit 6 are set (logical 1).

Table A2.2.9 Digital and Software Bit Definitions (Bit 1 is MSB)

Bit(s)	Measurement	Contents
1-6	HCD-1B command message number	6 LSBs of cmd message sent to HCD-1B
7	HCD-1B message start word bit error status	0=error-free start word 1=error in start word
8	HCD-1B uplink message disposition	0=accepted 1=rejected

|1|2|3|4|5|6|7|8| HLM1B HCD COMMAND SUMMARY WORD E-0661

Bit(s)	Measurement	Contents
1-8	HCD-1B messages received and accepted counter	increments by one for each message accepted by HCD-1B (MOD 256)

|1|2|3|4|5|6|7|8| HLM1B MSG RCVD AND ACCEPTED COUNTER E-0662

Bit(s)	Measurement	Contents
1-8	HCD-1B messages received and rejected counter	increments by one for each message rejected by HCD-1B (MOD 256)

|1|2|3|4|5|6|7|8| HLM1B MSG RCVD AND RJCTD COUNTER E-0663

Bit(s)	Measurement	Contents
1-8	HCD-1B command frame errors detected counter	increments by one for each command frame detected with errors by HCD-1B (MOD 256)

|1|2|3|4|5|6|7|8| HLM1B CMD FRAME ERRORS DETECTED COUNTER E-0664

Bit(s)	Measurement	Contents
1-8	HCD-1B data frame errors corrected counter	increments by one for each data frame corrected by HCD-1B (MOD 256)

|1|2|3|4|5|6|7|8| HLM1B DATA FRAME ERRORS CORRECTED COUNTER E-0665

Bit(s)	Measurement	Contents
1-8	HCD-1B data frame errors uncorrectable counter	increments by one for each erroneous data frame uncorrectable by HCD-1B (MOD 256)

|1|2|3|4|5|6|7|8| HLM1B DATA FRAME ERRORS UNCORRECTABLE COUNTER E-0666

Bit(s)	Measurement	Contents
1-8	HCD-1B lock changes counter	increments by one for each lock change provided to HCD-1B (MOD 256)

|1|2|3|4|5|6|7|8| HLM1B LOCK CHANGES COUNTER E-0667

Table A2.2.9 Digital and Software Bit Definitions (Bit 1 is MSB)

Bit(s)	Measurement	Contents
1	CRC-1B BA write busy error status	0=no error 1=write attempt when busy
2	CRC-1B BA write protect error status	no error 1=error
3	CRC-1B command block write attempt	0=no attempt 1=one or more attempts
4	CRC-1B power converter/ HCD POR status	0=no POR 1=one or more PORs
5	spare	
6	multiple frame CMD with zero data frames	0=no error 1=one or more errors
7	CRC-1B BA BUS parity error status	0=no error 1=one or more errors, any BA involved
8	CRC-1B BA transaction parity error status	0=no error 1=one or more errors, CRC-1B BA involved

|1|2|3|4|5|6|7|8| HLM1B SPUN CRC STATUS WORD E-0668 AND
HLM1B SPUN CRC BANK A E-0658

Table A2.2.9 Digital and Software Bit Definitions (Bit 1 is MSB)

Bit(s)	Measurement	Contents
1	BUS-1B overrun status	0=no overrun 1=overrun error, bus transaction in process at RTI
2	HLM-1B self-test failure status	0=pass 1=fail
3	HLM-1B keep-alive POR status	0=no KAPOR 1=one or more KAPORs with memory loss
4	HLM-1B POR status	0=no POR 1=one or more PORs, any power failure
5	HLM-1B microprocessor sync-idle error status	0=in sync 1=out of sync (1802 vs BIS) /idle lockup
6	HLM-1B BA bus parity error status - despun mux	0=no error 1=one or more errors, any BA involved (DESPUN MUX)
7	HLM-1B BA bus parity error status	0=no error 1=one or more errors, any BA involved(BC or SPUN MUX)
8	HLM-1B BA transaction parity error status	0=no error 1=one or more errors, HLM-1B BA involved

|1|2|3|4|5|6|7|8| HLM1B ERROR WORDS IOSL 0-1-2 (MSB) E-0669

Table A2.2.9 Digital and Software Bit Definitions (Bit 1 is MSB)

Bit(s)	Measurement	Contents
1	HCD parity error status	0=no error 1=one or more parity errors from HCD to HLM-1B
2	HLM-1B microprocessor memory read parity error status	0=no error 1=one or more parity errors when memory read by processor
3	HLM-1B BA memory read parity error status	0=no error 1=one or more parity errors when memory read by BA
4	HLM-1B bus controller memory read parity error status	0=no error 1=one or more parity errors when memory read by BC
5	HLM-1B microprocessor lockout status	0=no MPLO 1=MPLO
6	HLM-1B BA write protect error status	0=no error 1=write attempt by BA into protected memory
7	HLM-1B microprocessor write protect error status	0=no error 1=write attempt by processor into protected memory
8	HCD write protect error status	0=no error 1=write attempt by HCD into protected memory

|1|2|3|4|5|6|7|8| HLM1B ERROR WORDS IOSL 0-1-2 (2SB) E-0669

Bit(s)	Measurement	Contents
1-2	grounded spare	0
3	PLL-1B timing chain select status	0=timing chain A 1=timing chain B
4	PLL-1A timing chain select status	0=timing chain A 1=timing chain B
5-6	grounded spare	0
7	phase locked loop 1B POR status	0=no POR 1=one or more PORs
8	phase locked loop 1A POR status	0=no POR 1=one or more PORs

|1|2|3|4|5|6|7|8| HLM1B ERROR WORDS IOSL 0-1-2 (LSB) E-0669

Table A2.2.9 Digital and Software Bit Definitions (Bit 1 is MSB)

HLM1B BUM ERROR WORDS (MSB) E-0671

Bit(s)	Measurement	Contents
1-3	spare	
4	BUM-1A POR status	0=no POR 1=one or more PORs
5	BUM-1A BA-2B bus parity error status	0=no error 1=one or more parity errors involving any BA on its bus
6	BUM-1A BA-2B transaction parity error status	0=no error 1=one or more parity errors involving BUM-1A's BA-2B
7	BUM-1A BA-1A bus parity error status	0=no error 1=one or more parity errors involving any BA on its bus
8	BUM-1A BA-1A transaction parity error status	0=no error 1=one or more parity errors involving BUM-1A's BA-1A

HLM1B BUM ERROR WORDS (2SB) E-0671

Bit(s)	Measurement	Contents
1	BUM-1A telemetry formatter memory read parity error status	0=no error 1=one or more parity errors when memory read by formatter
2	BUM-1A telemetry sequencer memory read parity error status	0=no error 1=one or more parity errors when memory read by sequencer
3	BUM-1A BA-2B memory read parity error status	0=no error 1=one or more parity errors when memory read by BA-2B
4	BUM-1A BA-1A memory read parity error status	0=no error 1=one or more parity errors when memory read by BA-1A
5-6	spare	
7	BUM-1A BA-1A write protect error status	0=no error 1=write attempt by BA-2B into protected memory
8	BUM-1A BA-1A write protect error status	0=no error 1=write attempt by BA-1A into protected memory

Table A2.2.9 Digital and Software Bit Definitions (Bit 1 is MSB)

HLM1B BUM ERROR WORDS (3SB) E-0671

Bit(s)	Measurement	Contents
1-3	spare	
4	BUM-1B POR status	0=no POR 1=one or more PORs
5	BUM-1B BA-2A bus parity error status	0=no error 1=one or more parity errors involving any BA on its bus
6	BUM-1B BA-2A transaction parity error status	0=no error 1=one or more parity errors involving BUM-1B's BA-2A
7	BUM-1B BA-1B bus parity error status	0=no error 1=one or more parity errors involving any BA on its bus
8	BUM-1B BA-1B transaction parity error status	0=no error 1=one or more parity errors involving BUM-1B's BA-1B

HLM1B BUM ERROR WORDS (LSB) E-0671

Bit(s)	Measurement	Contents
1	BUM-1B telemetry formatter memory read parity error status	0=no error 1=one or more parity errors when memory read by formatter
2	BUM-1B telemetry sequencer memory read parity error status	0=no error 1=one or more parity errors when memory read by sequencer
3	BUM-1B BA-2A memory read parity error status	0=no error 1=one or more parity errors when memory read by BA-2A
4	BUM-1B BA-1B memory read parity error status	0=no error 1=one or more parity errors when memory read by BA-1B
5-6	spare	
7	BUM-1B BA-2A write protect error status	0=no error 1=write attempt by BA-2A into protected memory
8	BUM-1B BA-1B write protect error status	0=no error 1=write attempt by BA-1B into protected memory

Table A2.2.9 Digital and Software Bit Definitions (Bit 1 is MSB)

Bit(s)	Measurement	Contents
1	DMS illegal command status	0=no illegal command 1=illegal cmd (not per DMS CMD dictionary)
2	DBUM-1A sequencer output memory read parity error status	0=no error 1=one or more parity errors when memory read by DBUM sequencer
3	DBUM-1A formatter memory read parity error status	0=no error 1=one or more parity errors when memory read by formatter
4	DBUM-1A bus adapter memory read parity error status	0=no error 1=one or more parity errors when memory read by BA
5	DMS tape direction status	0=forward 1=reverse
6	DBUM-1A POR status	0=no POR 1=one or more PORs
7	DBUM-1A bus adapter bus parity error status	0=no error 1=one or more parity errors involving any BA
8	DBUM-1A BA transaction parity error status	0=no error 1=one or more parity errors involving DBUM-1A BA

|1|2|3|4|5|6|7|8| HLM1B DBUM ERROR WORDS (MSB) E-0672 Note 1

Note 1 - This data not valid unless DBUM-1A switched to B string.

Table A2.2.9 Digital and Software Bit Definitions (Bit 1 is MSB)

Bit(s)	Measurement	Contents
1	DMS illegal command status	0=no illegal command 1=illegal cmd (not per DMS CMD dictionary)
2	DBUM-1B sequencer output memory read parity error status	0=no error 1=one or more parity errors when memory read by DBUM sequencer
3	DBUM-1B formatter memory read parity error status	0=no error 1=one or more parity errors when memory read by formatter
4	DBUM-1B bus adapter memory read parity error status	0=no error 1=one or more parity errors when memory read by BA
5	DMS tape direction status	0=forward 1=reverse
6	DBUM-1B POR status	0=no POR 1=one or more PORs
7	DBUM-1B bus adapter bus parity error status	0=no error 1=one or more parity errors involving any BA
8	DBUM-1B BA transaction parity error status	0=no error 1=one or more parity errors involving DBUM-1B BA

|1|2|3|4|5|6|7|8| HLM1B DBUM ERROR WORDS (LSB) E-0672 Note 1

Bit(s)	Measurement	Contents
1	LLM-1B microprocessor lockout status	0=no MPLO 1=MPLO
2	LLM-1B self-test failure status	0=pass 1=fail
3	CC/DC in-process status	0=no cmd beginning execute 1=cmd beginning execute
4	LLM-1B POR status	0=no POR 1=one or more PORs, any power failure
5	LLM-1B microprocessor sync-idle error status	0=in sync 1=out of sync (1802 vs BIS) /idle lockup
6	CC/DC hardware buffer full status	0=empty 1=full
7	LLM-1B BA bus parity error status	0=no error 1=one or more errors, any BA involved
8	LLM-1B BA transaction parity error status	0=no error 1=one or more errors, LLM-1B BA involved

|1|2|3|4|5|6|7|8| LLM1B ERROR WORD-1 IOSL-0 E-0913

Note 1 - This data not valid unless DBUM-1B switched to B string.

Table A2.2.9 Digital and Software Bit Definitions (Bit 1 is MSB)

Bit(s)	Measurement	Contents
1	LLM-1B TLM port memory read parity error status	0=no error 1=one or more parity errors when memory read by TLM port
2	LLM-1B microprocessor memory read parity error status	0=no error 1=one or more parity errors when memory read by processor
3	LLM-1B BA memory read parity error status	0=no error 1=one or more parity errors when memory read by BA
4	engineering control port memory read parity error status	0=no error 1=one or more parity errors when memory read by engr. control port
5	CC/DC error status	0=overwrite not attempted 1=attempt to load CC/DC H/W buffer when already full
6	LLM-1B BA write protect error status	0=no error 1=write attempt by BA into protected memory, or I/O selects
7	LLM-1B microprocessor write protect error status	0=no error 1=write attempt by processor into protected memory
8	engineering data port write protect error status	0=no error 1=write attempt by engr. data port into protected memory

|1|2|3|4|5|6|7|8| LLM1B ERROR WORD-2 IOSL-1 E-0914

Bit(s)	Measurement	Contents
1	DMS BOT/EOT status	0=BOT 1=EOT
2	DMS leader/tape status	0=on tape 1=on leader
3-8	tic count status (6 MSB)	6 MSBs of the 14 bit tic count

|1|2|3|4|5|6|7|8| LLM1B DMS TAPE POSITION ESTIMATE MSB E-0923

Bit(s)	Measurement	Contents
1-8	tic count status (8 LSB)	8 LSBs of the 14 bit tic count

|1|2|3|4|5|6|7|8| LLM1B DMS TAPE POSITION ESTIMATE LSB E-0924

Table A2.2.9 Digital and Software Bit Definitions (Bit 1 is MSB)

Bit(s)	Measurement	Contents
1	LLM-2B microprocessor lockout status	0=no MPLO 1=MPLO
2	LLM-2B self-test failure status	0=pass 1=fail
3	CC/DC in-process status	0=no cmd beginning execute 1=cmd beginning execute
4	LLM-2B POR status	0=no POR 1=one or more PORs, any power failure
5	LLM-2B microprocessor sync-idle error status	0=in sync 1=out of sync (1802 vs BIS) /idle lockup
6	CC/DC hardware buffer full status	0=empty 1=full
7	LLM-2B BA bus parity error status	0=no error 1=one or more errors, any BA involved
8	LLM-2B BA transaction parity error status	0=no error 1=one or more errors, LLM-2B BA involved

|1|2|3|4|5|6|7|8| LLM2B ERROR WORD-1 IOSL-0 E-0973

Table A2.2.9 Digital and Software Bit Definitions (Bit 1 is MSB)

Bit(s)	Measurement	Contents
1	LLM-2B TLM port memory read parity error status	0=no error 1=one or more parity errors when memory read by TLM port
2	LLM-2B microprocessor memory read parity error status	0=no error 1=one or more parity errors when memory read by processor
3	LLM-2B BA memory read parity error status	0=no error 1=one or more parity errors when memory read by BA
4	engineering control port memory read parity error status	0=no error 1=one or more parity errors when memory read by engr. control port
5	CC/DC error status	0=overwrite not attempted 1=attempt to load CC/DC H/W buffer when already full
6	LLM-2B BA write protect error status	0=no error 1=write attempt by BA into protected memory, or I/O selects
7	LLM-2B microprocessor write protect error status	0=no error 1=write attempt by processor into protected memory
8	engineering data port write protect error status	0=no error 1=write attempt by engr. data port into protected memory

|1|2|3|4|5|6|7|8| LLM2B ERROR WORD-2 IOSL-1 E-0974

Table A2.2.9. Digital and Software Bit Definitions (Bit 1 is MSB)
Software Bit Definitions (AACS)

Bit(s)	Measurement	Contents
1	PA 10N Pre-drive status	0=no pre-drive present 1=pre-drive present
2	PA PDE 10N drive status	0=no drive present 1=drive present
3	PA status	0=disabled 1=enabled
4	PA integrity toggle	A toggle event, explicitly traceable to the commanding of an LV from closed to open with the other LV on the same branch already open, indicates proper operation of thruster disable, event counters & fault detectors.
5-6	PA 10N thruster disable event counter	= # of PA thruster disable events
7	ACE I/O identifier	0=I/O B selected 1=I/O A selected
8	spare	

|1|2|3|4|5|6|7|8| RPM Isovalve and PDE Annex Status (MSB) E-1254

Bit(s)	Measurement	Contents
9	spare	
10	spare	
11	400N fuel line valve position, LV43	0=closed 1=open
12	branch A fuel line position, LV42	0=closed 1=open
13	branch B fuel line valve position, LV41	0=closed 1=open
14	400N oxidizer line valve position, LV33	0=closed 1=open
15	branch A oxidizer line valve position, LV32	0=closed 1=open
16	branch B oxidizer line valve position, LV31	0=closed 1=open

| 9|10|11|12|13|14|15|16| RPM Isovalve and PDE Annex Status (LSB) E-1254

E-0115 through E-1161 - TBD
E-1326 through E-1471 - TBD

Table A2.2.9. Digital and Software Bit Definitions (Bit 1 is MSB)

Bit(s)	Measurement	Contents
1	LGA-2 boom deploy status	0=not deployed 1=deployed
2	PPS MPS 30VDC pwr enable status K1 & K3	0=power enabled 1=power disabled
3	LGA-2 boom stow status	0=stowed 1=not stowed
4	DEV nutation damper spring rate	0=not in high rate 1=high rate
5	SXA HGA deploy status	0=deployed 1=not deployed
6	DEV MAG boom deploy status	0=deployed 1=not deployed
7	DEV sci boom deploy status	0=deployed 1=not deployed
8	DEV +X RTG boom deploy status	0=deployed 1=not deployed

|1|2|3|4|5|6|7|8| PPS/DEV/SXA status word E-1635

Bit(s)	Measurement	Contents
1	spare (dedicated to SXA)	
2	PPS MPS 30VDC pwr enable status K2 & K4	0=power enabled 1=power disabled
3	spare bilevel (dedicated to SXA)	
4	DDS cover status	0=open 1=closed
5	SXA HGA tip latch release status	0=released 1=stowed
6	DEV MAG boom release status	0=released 1=stowed
7	spare (dedicated to SXA)	
8	DEV -X RTG boom deploy status	0=deployed 1=not deployed

|1|2|3|4|5|6|7|8| PPS/DEV/SXA/DDS status word E-1636

Table A2.2.9. Digital and Software Bit Definitions (Bit 1 is MSB)

DMS Status Data (A) E-1650

Bit(s)	Measurement	Contents
1-2	direction/track	00=reverse/track 4 01=reverse/track 2 10=forward/track 1 11=forward/track 3
3-5	data rate	000=7.68 kb/s 001=100.8 kb/s 010=28.8 kb/s 011=403.2 kb/s 100=19.2 kb/s 101=115.2 kb/s 110=57.6 kb/s 111=806.4 kb/s
6-7	mode	00=ready 01=record 10=playback 11=slew
8	servo lock	0=in lock 1=out of lock

|1|2|3|4|5|6|7|8| DMS Status Data (A) E-1650

DMS Status Data (B) E-1651

Bit(s)	Measurement	Contents
1-2	direction/track	00=reverse/track 4 01=reverse/track 2 10=forward/track 1 11=forward/track 3
3-5	data rate	000=7.68 kb/s 001=100.8 kb/s 010=28.8 kb/s 011=403.2 kb/s 100=19.2 kb/s 101=115.2 kb/s 110=57.6 kb/s 111=806.4 kb/s
6-7	mode	00=ready 01=record 10=playback 11=slew
8	servo lock	0=in lock 1=out of lock

|1|2|3|4|5|6|7|8| DMS Status Data (B) E-1651

Table A2.2.9. Digital and Software Bit Definitions (Bit 1 is MSB)

IUS status word 1 — E-1665

Bit(s)	Measurement	Contents
1	IUS attached discrete cmd 1A	0=cmd not received 1=cmd received
2	IUS attached discrete cmd 2A	0=cmd not received 1=cmd received
3	IUS attached discrete cmd 3A	0=cmd not received 1=cmd received
4	IUS attached discrete cmd 4A	0=cmd not received 1=cmd received
5	IUS attached discrete cmd 5A	0=cmd not received 1=cmd received
6	IUS attached discrete cmd 6A	0=cmd not received 1=cmd received
7	IUS attached discrete cmd 7A	0=cmd not received 1=cmd received
8	IUS attached discrete cmd 8A	0=cmd not received 1=cmd received

IUS status word 2 — E-1666

Bit(s)	Measurement	Contents
1	IUS attached discrete cmd 1B	0=cmd not received 1=cmd received
2	IUS attached discrete cmd 2B	0=cmd not received 1=cmd received
3	IUS attached discrete cmd 3B	0=cmd not received 1=cmd received
4	IUS attached discrete cmd 4B	0=cmd not received 1=cmd received
5	IUS attached discrete cmd 5B	0=cmd not received 1=cmd received
6	IUS attached discrete cmd 6B	0=cmd not received 1=cmd received
7	IUS attached discrete cmd 7B	0=cmd not received 1=cmd received
8	IUS attached discrete cmd 8B	0=cmd not received 1=cmd received

Table A2.2.9. Digital and Software Bit Definitions (Bit 1 is MSB)

Bit(s)	Measurement	Contents
1	RRH oscillator 2 on/off status	0=off 1=on
2	RRH receiver 1 standby mode	0=not in standby mode 1=in standby mode
3	IUS-SO separation ind. A	0=separated 1=attached
4	RRH receiver 2 wideband mode	0=not in wideband mode 1=in wideband mode
5	PRB spiu cst tmr pwr relay 1 status	0=off 1=on
6	PRB spiu g-sw pwr relay 3 status	0=off 1=on
7	PRB spiu g-sw pwr relay 6 status	0=off 1=on
8	PRB PROBE separation indicator 1	0=attached 1=separated

|1|2|3|4|5|6|7|8| Probe/RRH status word 1 E-1950

Bit(s)	Measurement	Contents
1	RRH oscillator 1 on/off status	0=off 1=on
2	RRH receiver 2 standby mode	0=not in standby mode 1=in standby mode
3	IUS-SO separation ind. B	0=separated 1=attached
4	RRH receiver 1 wideband mode	0=not in wideband mode 1=in wideband mode
5	PRB spiu cst tmr pwr relay 2 status	0=off 1=on
6	PRB spiu g-sw pwr relay 4 status	0=off 1=on
7	PRB spiu g-sw pwr relay 5 status	0=off 1=on
8	PRB PROBE separation indicator 2	0=attached 1=separated

|1|2|3|4|5|6|7|8| Probe/RRH status word 2 E-1951

A2.2.14.4 <u>CDS Treeswitch Assignments.</u> Table A2.2.10 identifies the usage of CDS treeswitch positions by reference to the engineering measurement numbers defined in Table A2.2.8.

Table A2.2.10 CDS Treeswitch Assignments

Tree Position	Tree T1A	T1B	T2A	T2B
00	E-0018	E-0019	E-1665	E-1666
01	E-0065	E-0066	E-0067	E-0068
02	E-1635	E-1636	E-1950	E-1951
03	E-0058	E-0062	not avail.	not avail.
04	E-0057 (MSB)	E-0061 (MSB)	not avail.	not avail.
05	E-0057 (LSB)	E-0061 (LSB)	not avail.	not avail.
06	not avail.	not avail.	not avail.	not avail.
07	not avail.	not avail.	not avail.	not avail.
08	E-0020	E-0052	not avail.	not avail.
09	E-0053	E-0021	not avail.	not avail.
0A	E-0055	E-0059	not avail.	not avail.
0B	E-0056	E-0060	not avail.	not avail.
0C	E-1650	E-1651	not avail.	not avail.
0D	not avail.	not avail.	not avail.	not avail.
0E	not avail.	not avail.	not avail.	not avail.
0F	not avail.	not avail.	not avail.	not avail.
10	E-1100	E-1120	spare	not avail.
11	E-1101	E-1121	spare	not avail.
12	E-1102	E-1122	spare	not avail.
13	E-1103	E-1123	spare	not avail.
14	E-1104	E-1124	spare	not avail.
15	E-1105	E-1125	E-0071	not avail.
16	E-1106	E-1126	spare	not avail.
17	E-1107	E-1127	spare	not avail.
18	E-0080	E-0081	E-0092	not avail.
19	E-0042	E-0101	spare	not avail.
1A	E-1585	E-0102	spare	not avail.
1B	E-0030	E-0040	spare	not avail.
1C	E-0039	E-0103	spare	not avail.
1D	E-0078	E-0104	spare	not avail.
1E	E-0105	E-1506	spare	not avail.
1F	E-1141	E-1148	E-1155	not avail.
20	E-1586	E-1589	spare	not avail.
21	E-0107	E-0041	spare	not avail.
22	E-0108	E-0106	spare	not avail.
23	E-0082	E-0083	spare	not avail.
24	E-0031	E-0027	spare	not avail.
25	spare	spare	E-1136	not avail.
26	E-0109	E-1500	E-0077	not avail.
27	E-1501	E-0070	E-0093	not avail.
28	E-1108	E-1128	spare	not avail.
29	E-1505	E-1507	spare	not avail.

Table A2.2.10 CDS Treeswitch Assignments (Cont'd)

Tree Position	Tree T1A	T1B	T2A	T2B
2A	E-0032	E-0037	spare	not avail.
2B	E-0095	E-0094	E-0072	not avail.
2C	E-1680	E-1590	spare	not avail.
2D	E-0034	E-0029	spare	not avail.
2E	E-1110	E-1130	spare	not avail.
2F	E-1142	E-1149	E-1156	not avail.
30	E-1652	E-1653	spare	not avail.
31	spare	E-1553	E-1970	not avail.
32	E-1980	E-1981	spare	not avail.
33	E-0024	E-0022	spare	not avail.
34	spare	E-0088	spare	not avail.
35	spare	spare	spare	not avail.
36	E-1551	E-0016	spare	not avail.
37	E-1552	spare	E-0079	not avail.
38	E-0038	E-0025	spare	not avail.
39	E-1591	E-1587	spare	not avail.
3A	spare	spare	spare	not avail.
3B	spare	E-0033	spare	not avail.
3C	E-0073	spare	E-0074	not avail.
3D	spare	E-1720	spare	not avail.
3E	E-0086	spare	spare	not avail.
3F	E-1143	E-1150	E-1157	not avail.
40	E-0090	E-0091	spare	not avail.
41	spare	E-0036	spare	not avail.
42	spare	E-1556	spare	not avail.
43	spare	E-0087	spare	not avail.
44	E-1588	spare	spare	not avail.
45	spare	spare	spare	not avail.
46	E-0023	E-0026	spare	not avail.
47	spare	spare	spare	not avail.
48	spare	spare	spare	not avail.
49	spare	E-1594	spare	not avail.
4A	E-0069	E-0075	spare	not avail.
4B	E-1109	E-1129	E-1960	not avail.
4C	E-0028	E-0035	spare	not avail.
4D	spare	spare	E-0076	not avail.
4E	E-1486	E-1487	spare	not avail.
4F	E-1144	E-1151	E-1158	not avail.
50	E-1660	E-1659	E-1952	not avail.
51	E-1613	E-1595	E-1910	not avail.
52	E-1643	E-1608	E-1913	not avail.
53	E-1607	E-1649	E-0009	not avail.
54	E-0097	E-1640	E-1915	not avail.

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Table A2.2.10 CDS Treeswitch Assignments (Cont'd)

Tree Position	Tree T1A	T1B	T2A	T2B
55	E-1860	E-1604	E-1883	not avail.
56	E-1648	E-1485	E-1473	not avail.
57	E-0043	E-1863	E-1967	not avail.
58	E-1639	E-1644	E-1479	not avail.
59	E-1690	E-0100	E-1715	not avail.
5A	E-1618	E-1948	E-1475	not avail.
5B	E-0045	E-0050	E-0011	not avail.
5C	E-1600	E-1693	E-0008	not avail.
5D	E-1740	E-1751	E-1885	not avail.
5E	E-0000	E-0001	E-1916	not avail.
5F	E-1145	E-1152	E-1159	not avail.
60	E-1657	E-1612	E-1625	not avail.
61	E-0044	E-0046	E-1953	not avail.
62	E-1615	E-1722	E-1912	not avail.
63	E-1610	E-1609	E-1914	not avail.
64	E-1606	E-1605	E-1790	not avail.
65	E-1645	E-1641	E-1480	not avail.
66	E-1619	E-0003	E-0012	not avail.
67	E-0048	E-0051	E-0014	not avail.
68	E-1478	E-1477	E-1880	not avail.
69	E-1638	E-1692	E-1647	not avail.
6A	E-0004	E-1617	E-1966	not avail.
6B	E-1862	E-1982	E-1474	not avail.
6C	E-1602	E-1753	E-1481	not avail.
6D	E-1750	E-0098	E-1884	not avail.
6E	E-1557	E-0049	E-0015	not avail.
6F	E-1146	E-1153	E-1160	not avail.
70	E-1642	E-1658	E-1911	not avail.
71	E-1596	E-1620	E-1882	not avail.
72	E-1681	E-1614	E-1954	not avail.
73	E-1611	E-0017	spare	not avail.
74	E-1603	E-1599	E-1881	not avail.
75	E-1675	E-1646	E-1482	not avail.
76	E-0002	E-1472	E-1965	not avail.
77	E-0047	E-0005	E-0010	not avail.
78	E-1598	E-1597	E-1946	not avail.
79	E-1691	E-1861	E-1716	not avail.
7A	E-1483	E-1676	E-1476	not avail.
7B	E-0096	E-1616	E-0013	not avail.
7C	E-1752	E-1601	E-1947	not avail.
7D	E-0099	E-1637	E-1945	not avail.
7E	E-0006	E-0007	E-1968	not avail.
7F	E-1147	E-1154	E-1161	not avail.

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A2.3 Memory Readout Data

A2.3.1 Memory Readout Structure. The spacecraft data system shall provide a common structure for reading out any onboard computer memory. The structure shall support both 8 and 16 bit memory readouts.

The format of this structure is shown in Figure A2.3.1 and described in greater detail in Table A2.3.1.

```
 ------------------------------------------------------------        -------------
| CONTROL      |              |                             /       /              |
| ELEMENT      |              |     MEMORY READOUT          \       \     DATA     |
|--------------|              |______________________________\       \_____________|
|              |              |    |     |     |     |      \  32    |      |      |
|              |              | 8  |  8  |  8  |  8  |      /TOTAL  /|  8   |  8   |
|    BUS       | STARTING     |____|_____|_____|_____|__  /        /_|______|______|
|    USER      | MEMORY       |          |           |   \        \ |             |
|    CODE      | ADDRESS      |          |           |    \        \|             |
|              |              |    16    |     16    |    /  16    /|     16      |
|     8        |     16       |          |           |   / TOTAL/  |             |
|______________|______________|__________|___________|__/        \__|_____________|
```

Figure A2.3.1. Memory Readout Structure

Table A2.3.1. Memory Readout Structure

Data Description	Bits frame	Offset to Data Start	Paragraph
Bus User Code	8	0	A2.3.1.1
Starting Address	16	8	A2.3.1.2
Memory Readout Data	256	24	A2.3.1.3

A2.3.1.1 Bus User Codes. The Bus User Code area contains Bus source codes, and describes the data contained within the memory readout portion of the frame. The contents shall be interpreted in accordance with Table A2.3.2.

Table A2.3.2. Bus User Codes

Subsystem/ Module	Bus User (source) code	Data Field Width (bits)	Number of words in Frame
EPD	99	8	32
PPR	9B	8	32
DDS	9D	8	32
PLS	A0	8	32
UVS	A2	8	32
MAG	A3	8	32
SSI	A4	8	32
NIMS	A5	8	32
AACS-A	87	16	16
AACS-B	88	16	16
RRH-1	B4	8	32
RRH-2	B7	8	32
CDS			
HLM-1A	84	8	32
HLM-1B	85	8	32
LLM-1A	8C	8	32
LLM-1B	8D	8	32
LLM-2A	AC	8	32
LLM-2B	AD	8	32
BUM-1A-1A	90	8	32
BUM-1A-2B	91	8	32
BUM-1B-1B	94	8	32
BUM-1B-2A	95	8	32
DBUM-1A	8A	8	32
DBUM-1B	8B	8	32
CRC-1A	8E	8	32
CRC-1B	8F	8	32
CRC-2A	AE	8	32
CRC-2B	AF	8	32

A2.3.1.2 Starting Address. This field shall represent the address corresponding to the first memory readout word in the readout data.

In order to provide a consistent readout format for all spacecraft computer memories, the memory readout shall start at a specified address.

A2.3.1.3 Memory Readout Data. The data in this portion of the frame shall contain the contents of consecutive memory locations. The first data word shall be the contents of the memory location specified by the starting address field.

A2.3.1.3.1 Subsystem Memory. For any subsystem commanded memory readout, the number of consecutive memory locations read out per block shall be 16 or 32 corresponding to 16 or 8 bit processor word sizes respectively.

A2.3.1.3.2 Commutation Map Readout Data. In order to facilitate ground reconstruction of on-board engineering commutation maps, the maps shall be stored in a known location. In the event that the Orbiter partitions the engineering commutation maps among various CDS and AACS memories, the various partitions shall all be stored in known locations.

A2.3.2 Variable Packet Replacement Readout. The spacecraft data system shall have the capability to read out any on-board processor memory in the engineering data stream. The format of the variable packet replacement memory readout shall be as shown in Figure A2.3.2.

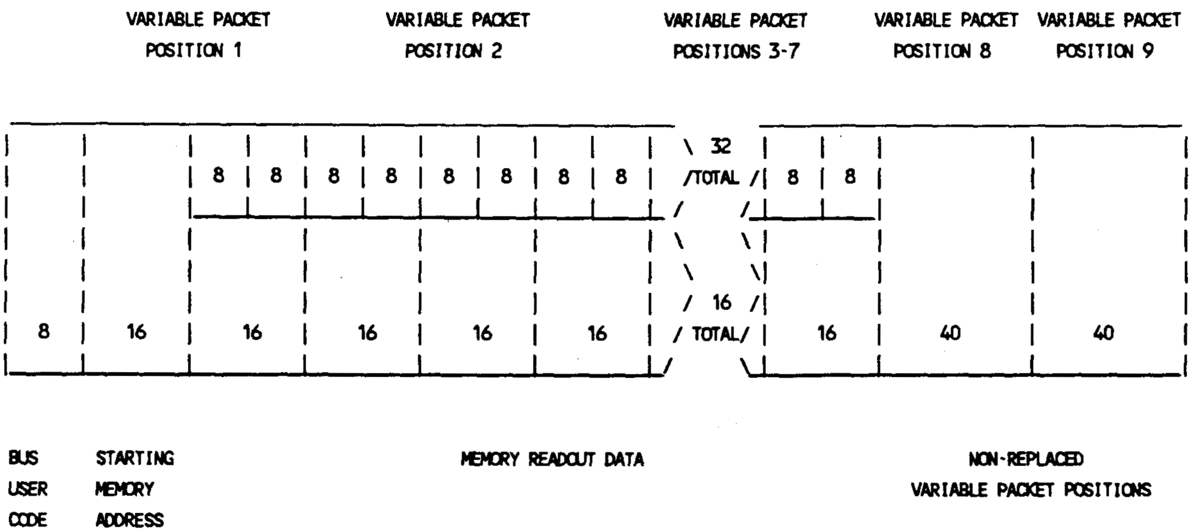


Figure A2.3.2. Variable Packet Replacement Memory Readout

A2.3.2.1 Description. The CDS shall collect the memory readout data from the desired subsystem and create a memory readout structure identical to paragraph A2.3.1. This structure will replace the first 7 variable packets in the engineering frame.

A2.3.3 Memory Readout Data Stream. The Sequence in which the 32-byte blocks of memory readout data appear in the engineering telemetry is dependent on both the engineering telemetry data rate and the memory readout mode selected within the CDS, as described in the following paragraphs.

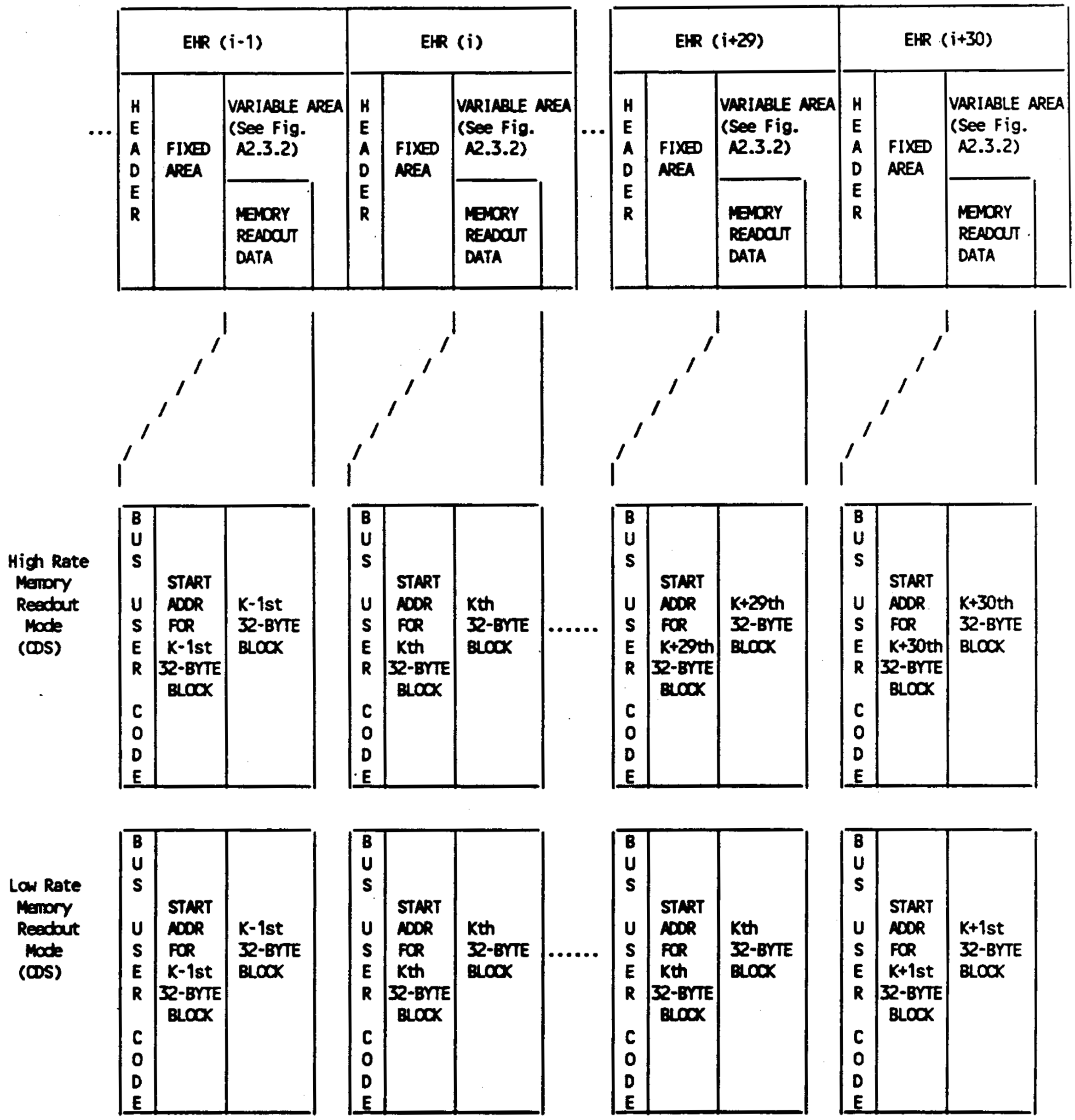


Figure A2.3.3.1. Memory Readout Sequence at 1200 b/s Engineering Telemetry (EHR).

A2.3.3.1 Memory Readout within 1200 b/s Engineering. Successive frames of the high rate engineering (EHR) shall contain 32-byte blocks of memory readout data from sequential locations when the high rate memory readout mode is selected. When the low rate memory readout data is selected, each 32-byte block of memory readout data shall appear in thirty successive high rate engineering frames. The sequence of memory readout data within the 1200 b/s engineering telemetry is depicted in Figure A2.3.3.1 for the high and low rate memory readout modes of the CDS.

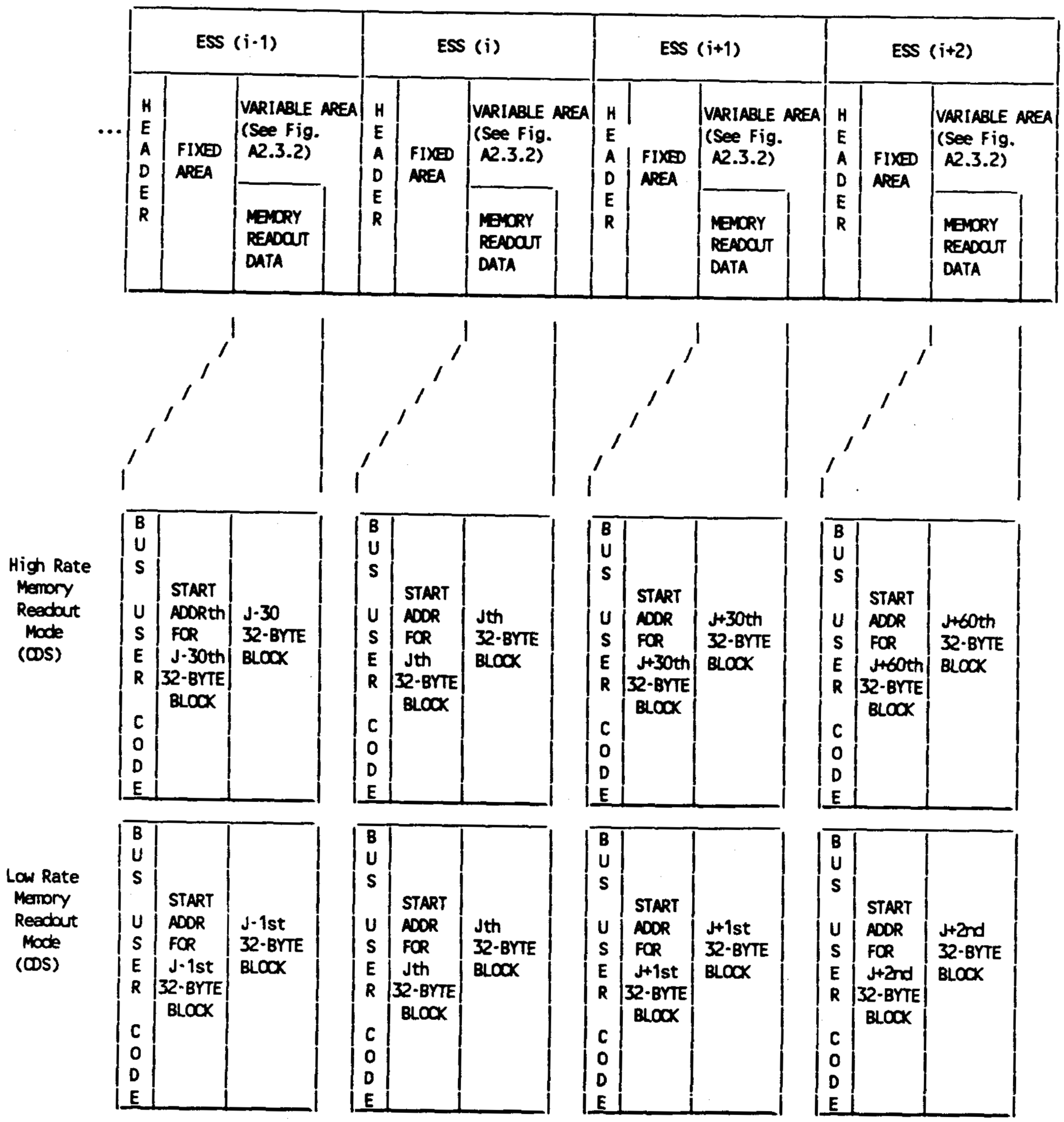


Figure A2.3.3.2 Memory Readout Sequence at 40 b/s Engineering Telemetry (ESS)

A2.3.3.2 Memory Readout within 40 b/s Engineering. Successive frames of 40 b/s snapshot engineering (ESS) shall contain 32-byte blocks of memory readout data from sequential locations when the low rate memory readout mode is selected. When the high rate memory readout mode is selected, every thirtieth 32-byte block of memory readout data shall appear in successive frames of the 40 b/s snapshot engineering. The sequence of memory readout data which shall appear within the 40 b/s (snapshot) engineering telemetry is depicted in Figure A2.3.3.2 for the high and low rate memory readout modes of the CDS.

A2.3.4 Memory Readout Sampling Time. All memory readout data shall be sampled between 476-2/3 and 533-1/3 milliseconds after the SCLK contained in the engineering frame header containing the readout.

A2.4 AACS POSITION AND RATE DATA

The AACS shall provide pointing vector and rate data. The pointing vector information shall be provided in the Earth Mean Equator (EME) 1950.0 coordinate system, the Ecliptic (ECL) 1950.0 coordinate system, and spacecraft relative coordinate system. The LRS data schematic is shown in Figure A2.4.1 and described further in Table A2.4.1.

EME - 50 COORDINATES									ECL - 50 COORDINATES	S/C RELATIVE COORDINATES	
ROTOR ATTITUDE			PLATFORM ATTITUDE			PLATFORM RATE		ROTOR SPIN MOTION DELTA	ROTOR SPIN POSITION ANGLE		
RA	DEC	TWIST	RA	DEC	TWIST	CONE	CROSS CONE			CONE POSITION	CLOCK POSITION
16	16	16	16	16	16	16	16	16	16	16	16

Figure A2.4.1. AACS Position and Rate Data

Table A2.4.1. AACS Position and Rate Data

Data Description	Bits Frame	Data Start	Comments(1)
Rotor Attitude (2)			The Least Significant Bit (LSB) represents $1/2^{16}$ revolution.
Right Ascension (RA)	16	0	
Declination (DEC)	16	16	
Twist (3)	16	32	
Platform Attitude (2)			The Least Significant Bit (LSB) represents $1/2^{16}$ revolution.
Right Ascension (RA)	16	48	
Declination (DEC)	16	64	
Twist (4)	16	80	
Platform Rate			The LSB represents 1/2 revolution during 8-1/3 millisecond interval.
Cone	16	96	
Cross Cone	16	112	
Rotor Spin Motion Delta	16	128	The LSB represents 1/2 revolution during 8-1/3 millisecond interval.
Rotor Spin Position Angle (2, 5)	16	144	The LSB represents 1/2 revolution
Cone Position (2, 6)	16	160	The LSB represents 1/2 revolution
Clock Position (2, 7)	16	176	

Notes:

(1) Data is a 16 bit 2's complement number.

(2) Data is predicted ahead to RTI 0.

(3) Rotor twist represents rotation about the spacecraft Z-axis. The twist angle shall be defined as the angle from the projection of the Earth's North Pole onto the X-Y plane to the Rotor -X-axis (positive rotation about the Z-axis provides a positive twist angle.)

(4) Platform twist represents rotation about the scan platform boresight (L- axis). The twist angle shall be defined as the angle from the projection of the Earth's North Pole onto the M-N plane to the scan platform -M-axis (positive rotation about the L-axis provides a positive twist angle.

(5) Spin position angle represents the angle from the projection of the North Ecliptic Pole vector on the X-Y plane to the -X-axis. Positive rotation about the Z-axis provides a positive spin position angle.

(6) Cone position represents the null offset corrected encoder angle between the -Z-axis and the scan platform boresight (L-axis). An increasing encoder reading represents an increasing +N rotation of the scan platform with respect to the stator.

(7) Clock position represents the null offset corrected angle between the -Y-axis of the rotor and the SAS shaft (-N-axis, nominally the -Y-axis of the stator). An increasing encoder reading represents an increasing -Z rotation of the rotor with respect to the stator.

A2.5 **DUST DETECTOR SUBSYSTEM TELEMETRY**

This paragraph describes the format and content of the DDS output.

A2.5.1 DDS Packet. The schematic of this packet is shown in Figure A2.5.1. One full DDS packet is distributed over 13 LRS frames.

	DDS Science Data	Digital Status and Analog Engineering
Title	DDS Science Data	Digital Status and Analog Engineering
Data Offset	0	120
Bits/packet	120	88
Description	A2.5.3	A2.5.4

Figure A2.5.1 DDS Packet

A2.5.2 Instrument Synchronicity. Within the DDS packet, there will exist one major synchronism relative to the SCLK. The relationship of the start of the DDS packet to SCLK and synchronization index (SI) is shown in Table A2.5.1.

Table A2.5.1 Relationship of SI and SCLK to start of DDS packet

SI	MOD 91	DDS Packet #
0	1	1st packet
1	14	2nd packet
2	27	3rd packet
3	40	4th packet
4	53	5th packet
5	66	6th packet
6	79	7th packet

A2.5.3 DDS Science Data. The DDS Science Data section may contain 3 different data types, dependant on the mode selected. Mode 1 is the science collection mode. The first 15 bytes of data (1 through 15) contain dust detection information. The contents of this section are then shown in Table A2.5.2.

Mode 2 is a memory read-out mode. In the memory readout mode, the first byte of DDS data contains the 8 MSB's of the starting address of the memory readout, and the next byte contains the 8 LSB's of the starting address. The next 13 bytes of data (3 through 15) contain memory readout data.

Table A2.5.2 DDS Science Data (MSB is bit 1)

DDS Byte	Bit(s)	Measurement	Contents
DDS Byte 1	1-6	ion grid amplifier output	10^{-14} to 10^{-8} Coulombs
	7-8	ion grid threshold	threshold value in binary
DDS Byte 2	1	threshold status	0=commanded 1=automatic
	2-6	channeltron output	10^{-12} to 10^{-10} Coulombs
	7-8	channeltron threshold	threshold value in binary
DDS Byte 3	1-6	target pulse amplifier output	10^{-14} to 10^{-8} Coulombs
	7-8	electron pulse threshold	threshold value in binary
DDS Byte 4	1-6	entrance grid amplitude output	10^{-15} to 10^{-11} Cb(neg.) 10^{-15} to 10^{-13} Cb(pos.)
	7-8	primary pulse threshold	threshold value in binary
DDS Byte 5	1-5	entrance grid-target flighttime	1 to 400 microseconds
	6-8	event definition	000=any channel 001=Qc, Qi 010=Qc, Qe 011=Qc 100=Qi, Qe 101=Qi 110=Qe 111=n/a
DDS Byte 6	1-4	target pulse risetime	10 to 100 microseconds
	5-8	ion grid pulse risetime	10 to 100 microseconds

Table A2.5.2 DDS Science Data (MSB is bit 1)

Bit(s)	Measurement	Contents
1-4	target-ion grid flighttime	1 to 50 microseconds
5	target-ion grid coincidence	0=no coincidence 1=coincidence
6	ion grid-channeltron coincidence	0=no coincidence 1=coincidence
7-8	event class number	class number in binary

DDS Byte 7

Bit(s)	Measurement	Contents
1-4	measurement of entrance grid noise pulses detected	binary number
5-8	target noise pulses detected	binary number

DDS Byte 8

Bit(s)	Measurement	Contents
1-4	ion grid noise pulses detected	binary number
5-8	channeltron noise pulses detected	binary number

DDS Byte 9

Bit(s)	Measurement	Contents
1-8	class counter 0	binary count

DDS Byte 10

Bit(s)	Measurement	Contents
1-8	class counter 1	binary count

DDS Byte 11

Bit(s)	Measurement	Contents
1-8	class counter 2	binary count

DDS Byte 12

Bit(s)	Measurement	Contents
1-8	class counter 3	binary count

DDS Byte 13

Table A2.5.2 DDS Science Data (MSB is bit 1)

Bit(s)	Measurement	Contents
1-4	S/C time of event	4 LSB of RIM
5-8	S/C time of event	bits 2 through 5 of MOD 91 count

|1|2|3|4|5|6|7|8| DDS Byte 14

Bit(s)	Measurement	Contents
1-8	sector data	8 MSB of sum of spin position angle and spin motion delta

|1|2|3|4|5|6|7|8| DDS Byte 15

Mode 3 is the instrument set point. In the set point mode, two packets of DDS data will contain set point data. The first packet of data is identified by byte 16 as being set points 1. This packet will contain 15 bytes of set point data, as identified in Table A2.5.3. The next DDS packet will be identified by byte 16 as being set points 2, and will contain 5 bytes of set point data and 10 bytes of random fill data.

Table A2.5.3 DDS Instrument Set Point Data

Bit(s)	Measurement	Contents
1-8	IT threshold, low level	0 to 255, commandable

|1|2|3|4|5|6|7|8| DDS set points 1 Byte 1

Bit(s)	Measurement	Contents
1-8	IT threshold, high level	0 to 255, commandable

|1|2|3|4|5|6|7|8| DDS set points 1 Byte 2

Bit(s)	Measurement	Contents
1-8	ET threshold, low level	0 to 255, commandable

|1|2|3|4|5|6|7|8| DDS set points 1 Byte 3

Bit(s)	Measurement	Contents
1-8	ET threshold, high level	0 to 255, commandable

|1|2|3|4|5|6|7|8| DDS set points 1 Byte 4

Bit(s)	Measurement	Contents
1-8	EIT threshold, low level	0 to 255, commandable

|1|2|3|4|5|6|7|8| DDS set points 1 Byte 5

Table A2.5.3 DDS Instrument Set Point Data

Bit(s)	Measurement	Contents
1-8	EIT threshold, high level	0 to 255, commandable

|1|2|3|4|5|6|7|8| DDS set points 1 Byte 6

Bit(s)	Measurement	Contents
1-8	SEC threshold, low level	0 to 255, commandable

|1|2|3|4|5|6|7|8| DDS set points 1 Byte 7

Bit(s)	Measurement	Contents
1-8	SEC threshold, high level	0 to 255, commandable

|1|2|3|4|5|6|7|8| DDS set points 1 Byte 8

Bit(s)	Measurement	Contents
1-8	IN threshold, high level	0 to 255, commandable

|1|2|3|4|5|6|7|8| DDS set points 1 Byte 9

Bit(s)	Measurement	Contents
1-8	CN threshold, high level	0 to 255, commandable

|1|2|3|4|5|6|7|8| DDS set points 1 Byte 10

Bit(s)	Measurement	Contents
1-8	EN threshold, high level	0 to 255, commandable

|1|2|3|4|5|6|7|8| DDS set points 1 Byte 11

Bit(s)	Measurement	Contents
1-8	PN threshold, high level	0 to 255, commandable

|1|2|3|4|5|6|7|8| DDS set points 1 Byte 12

Bit(s)	Measurement	Contents
1-8	PA threshold, low level	0 to 255, commandable

|1|2|3|4|5|6|7|8| DDS set points 1 Byte 13

Bit(s)	Measurement	Contents
1-8	EA threshold, low level	0 to 255, commandable

|1|2|3|4|5|6|7|8| DDS set points 1 Byte 14

Table A2.5.3 DDS Instrument Set Point Data

Byte	Bit(s)	Measurement	Contents
DDS set points 1 Byte 15	1-8	CA threshold, low level	0 to 255, commandable
DDS set points 2 Byte 1	1-8	IA threshold, low level	0 to 255, commandable
DDS set points 2 Byte 2	1-8	HVC threshold, low level	0 to 255, commandable
DDS set points 2 Byte 3	1-8	CUR threshold, high level	0 to 255, commandable
DDS set points 2 Byte 4	1-8	spare	
DDS set points 2 Byte 5	1-8	spare	

A2.5.4 Digital Status and Analog Engineering. The content of the Digital Status and Analog Engineering section is shown in Table A2.5.4.

Table A2.5.4 Digital Status & Analog Engineering (MSB is bit 1)

Bit(s)	Measurement	Contents
1-3	data frame number	000=A range science data 001=E range science data 010=set points 1 011=set points 2 100=auto test pulse 101=cmded test pulse 110=memory content 111=spare
4	mode 1:S/C sector data valid flag modes 2 & 3:spare	0=sector data not valid 1=sector data valid
5	mode 1:transmit status modes 2 & 3:spare	0=data not transmitted previously 1=data transmitted previously
6-8	mode 1:E range status modes 2 & 3:spares	E range science data 0-7

|1|2|3|4|5|6|7|8| DDS Byte 16

Bit(s)	Measurement	Contents
1-8	computer status	CPU status (CPU and memory check)

|1|2|3|4|5|6|7|8| DDS Byte 17

Bit(s)	Measurement	Contents
1-8	experiment current	15 to 100 ma.

|1|2|3|4|5|6|7|8| DDS Byte 18

Bit(s)	Measurement	Contents
1-8	HK channeltron high voltage	0 to 2500 volts

|1|2|3|4|5|6|7|8| DDS Byte 19

Bit(s)	Measurement	Contents
1-8	HK sensor ion grid high voltage	0 to -512 volts

|1|2|3|4|5|6|7|8| DDS Byte 20

Bit(s)	Measurement	Contents
1-8	HK +10 volts digital	0 to 15.36 volts

|1|2|3|4|5|6|7|8| DDS Byte 21

Table A2.5.4 Digital Status & Analog Engineering (MSB is bit 1)

DDS Byte	Bit(s)	Measurement	Contents
|1|2|3|4|5|6|7|8| DDS Byte 22	1-8	HK +7.5 volts analog	0 to 10 volts
|1|2|3|4|5|6|7|8| DDS Byte 23	1-8	HK -7.5 volts analog	0 to -10 volts
|1|2|3|4|5|6|7|8| DDS Byte 24	1-8	HK main electronics temperature	-30 degrees C to 80 degrees C
|1|2|3|4|5|6|7|8| DDS Byte 25	1-8	commutated parity error, cmds acc, or cmd rej	see byte 26, bits 7-8
|1|2|3|4|5|6|7|8| DDS Byte 26	1-6	synchronization word	101010 (binary)
	7-8	add-HK	determines whether byte 25 contains a parity error count, commands accepted, or commands rejected. 00=parity error count 01=cmds accepted count 10=cmds rejected count 11=spare

A2.5.5 Telemetry Mode Changes. Upon the application of system power, DDS shall generate valid housekeeping data, but the science data shall not be valid.

Commanded telemetry mode changes shall be processed every RIM. Telemetry mode changes shall occur on RIM changes.

A2.6 ENERGETIC PARTICLE DETECTOR SUBSYSTEM TELEMETRY

This paragraph describes the format and content of the EPD output.

A2.6.1 EPD Packet. The schematic of this packet is shown in Figure A2.6.1. One EPD packet is inserted in each LRS Frame.

Title	Analog House-keeping	Digital Status	CMS PHA/ LEMMS PHA Data	LEMMS PHA Data	Rate Channel Data
Data Offset	0	8	72	168	208
Bits/packet	8	64	96	40	400
Description	A2.6.3	A2.6.4	A2.6.5	A.2.6.6	A2.6.7

Figure A2.6.1 EPD Packet

A2.6.1 Instrument Synchronicity. Within the EPD packet there will exist one major synchronism relative to the SCLK. The EPD Synchronization Index is equal to the SCLK Mod 91 count.

A2.6.3 Analog Housekeeping. The Analog Housekeeping section is one byte of subcommutated data. The contents of the subcommutated positions are shown in Table A2.6.1

Table A2.6.1 Subcommutated Analog Housekeeping (bit 1 is MSB)

Bit(s)	Measurement	Contents
1-8	spare	

|2|3|4|5|6|7|8| EPD Subcommutated Housekeeping S.I.=0

Bit(s)	Measurement	Contents
1-8	spare	

|1|2|3|4|5|6|7|8| EPD Subcommutated Housekeeping S.I.=1

Bit(s)	Measurement	Contents
1-8	motor housing temp.	

|1|2|3|4|5|6|7|8| EPD Subcommutated Housekeeping S.I.=2

Table A2.6.1 Subcommutated Analog Housekeeping (bit 1 is MSB)

Bit(s)	Measurement	Contents
1	scan error	0=no error detected 1=error detected
2	fast scan abort flag	0=normal 1=fast scan aborted
3	emergency count flag	0=normal 1=means S.I.=3, bits 4-8 are now an emergency count number MOD 32
4	motor direction indicator	0=counter clockwise 1=clockwise
5	motor centerline indicator	0=motor not on center-line 1=motor on centerline
6-8	motor position code	sector 0-7

1 2 3 4 5 6 7 8

EPD Subcommutated Housekeeping S.I.=3

1	emergency mode indicator	0=normal 1=emergency mode (motor moves one step per trigger instead of one sector per trigger)
2	open loop mode indicator	0=closed loop 1=open loop
3	-in closed loop mode: modified scan -in open loop mode: limited scan	0=normal scan 1=modified scan 0=normal scan 1=limited scan
4	fast scan indicator	0=normal 1=fast scan
5	-in closed loop mode: go to sector N -in open loop mode: stop scanning after N triggers	0=normal 1=go to sector N, where N is value of S.I.=4, bits 6-8 0=normal 1=stop scanning after N triggers, where N is value if S.I.=4, bits 6-8
6-8	"N"	3 bit binary number

1 2 3 4 5 6 7 8

EPD Subcommutated Housekeeping S.I.=4

Table A2.6.1 Subcommutated Analog Housekeeping (bit 1 is MSB)

Bit(s)	Measurement	Contents
1	alternate step rate mode	0=normal (50 steps/sec.) 1=alternate step rate (60 steps/sec.)
2-4	CCW end-sector (N/A in open-loop mode	sector number
5	chicken mode (N/A open-loop mode)	0=normal 1=chicken mode
6-8	CW end-sector (N/A in open-loop mode)	sector number

|1|2|3|4|5|6|7|8|

EPD Subcommutated Housekeeping S.I.=5

1-8	autocalibrator index # 1	binary number identifies S.I.=7 contents

|1|2|3|4|5|6|7|8|

EPD Subcommutated Housekeeping S.I.=6

1-8	autocalibrator AGC voltage #1	0 to 5.1 volts

|1|2|3|4|5|6|7|8|

EPD Subcommutated Housekeeping S.I.=7

1-8	number of invalid motor commands	0 to 255 binary

|1|2|3|4|5|6|7|8|

EPD Subcommutated Housekeeping S.I.=8

1-2	spare	
3-7	step count	0 to 31 binary
8	cease scan flag	0=normal 1=cease scan

|1|2|3|4|5|6|7|8|

EPD Subcommutated Housekeeping S.I.=9

1-8	LEMMS telescope temp.	

|1|2|3|4|5|6|7|8|

EPD Subcommutated Housekeeping S.I.=10

Table A2.6.1 Subcommutated Analog Housekeeping (bit 1 is MSB)

EPD Subcommutated Housekeeping S.I.=11 (bits |1|2|3|4|5|6|7|8|)

Bit(s)	Measurement	Contents
1-8	number of invalid bus commands	0 to 255 binary

EPD Subcommutated Housekeeping S.I.=12 (bits |1|2|3|4|5|6|7|8|)

Bit(s)	Measurement	Contents
1-8	autocalibrator index # 2	binary number identifies S.I.=13 contents

EPD Subcommutated Housekeeping S.I.=13 (bits |1|2|3|4|5|6|7|8|)

Bit(s)	Measurement	Contents
1-8	autocalibrator AGC voltage #2	0 to 5.1 volts

EPD Subcommutated Housekeeping S.I.=14 (bits |1|2|3|4|5|6|7|8|)

Bit(s)	Measurement	Contents
1-8	MSB memory dump cursor	8 MSB's of memory dump address

EPD Subcommutated Housekeeping S.I.=15 (bits |1|2|3|4|5|6|7|8|)

Bit(s)	Measurement	Contents
1-8	motor dwell period	motor dwell period in units of 1.333 sec.

EPD Subcommutated Housekeeping S.I.=16 (bits |1|2|3|4|5|6|7|8|)

Bit(s)	Measurement	Contents
1-8	CMS telescope temp.	

EPD Subcommutated Housekeeping S.I.=17 (bits |1|2|3|4|5|6|7|8|)

Bit(s)	Measurement	Contents
1-8	number of supervisory bus parity errors detected	0 to 255 binary

EPD Subcommutated Housekeeping S.I.=18 (bits |1|2|3|4|5|6|7|8|)

Bit(s)	Measurement	Contents
1-8	autocalibrator index # 3	binary number identifies S.I.=19 contents

Table A2.6.1 Subcommutated Analog Housekeeping (bit 1 is MSB)

Bit(s)	Measurement	Contents
1-8	autocalibrator AGC voltage #3	0 to 5.1 volts

1	2	3	4	5	6	7	8

EPD Subcommutated Housekeeping S.I.=19

Bit(s)	Measurement	Contents
1-8	MSB upper memory checksum limit	8 MSB's of upper memory checksum limit

1	2	3	4	5	6	7	8

EPD Subcommutated Housekeeping S.I.=20

Bit(s)	Measurement	Contents
1-8	LSB upper memory checksum limit	8 LSB's of upper memory checksum limit

1	2	3	4	5	6	7	8

EPD Subcommutated Housekeeping S.I.=21

Bit(s)	Measurement	Contents
1-8	main elect. temp.	

1	2	3	4	5	6	7	8

EPD Subcommutated Housekeeping S.I.=22

Bit(s)	Measurement	Contents
1-8	memory checksum	

1	2	3	4	5	6	7	8

EPD Subcommutated Housekeeping S.I.=23

Bit(s)	Measurement	Contents
1-8	autocalibrator index # 4	binary number identifies S.I.=25 contents

1	2	3	4	5	6	7	8

EPD Subcommutated Housekeeping S.I.=24

Bit(s)	Measurement	Contents
1-8	autocalibrator AGC voltage # 4	0 to 5.1 volts

1	2	3	4	5	6	7	8

EPD Subcommutated Housekeeping S.I.=25

Bit(s)	Measurement	Contents
1-8	MSB lower memory checksum limit	8 MSB's of lower memory checksum limit

1	2	3	4	5	6	7	8

EPD Subcommutated Housekeeping S.I.=26

Table A2.6.1 Subcommutated Analog Housekeeping (bit 1 is MSB)

Bit(s)	Measurement	Contents
1-8	LSB lower memory checksum limit	8 LSB's of lower memory checksum limit

|1|2|3|4|5|6|7|8| EPD Subcommutated Housekeeping S.I.=27

Bit(s)	Measurement	Contents
1-8	EPD input current	

|1|2|3|4|5|6|7|8| EPD Subcommutated Housekeeping S.I.=28

Bit(s)	Measurement	Contents
1-8	number of supervisory bus parity errors detected during EPD bus transaction	0 to 255 binary

|1|2|3|4|5|6|7|8| EPD Subcommutated Housekeeping S.I.=29

Bit(s)	Measurement	Contents
1-8	autocalibrator index # 5	binary number identifies S.I.=31 contents

|1|2|3|4|5|6|7|8| EPD Subcommutated Housekeeping S.I.=30

Bit(s)	Measurement	Contents
1-8	autocalibrator AGC voltage # 5	0 to 5.1 volts

|1|2|3|4|5|6|7|8| EPD Subcommutated Housekeeping S.I.=31

Bit(s)	Measurement	Contents
1-8	spare	

|1|2|3|4|5|6|7|8| EPD Subcommutated Housekeeping S.I.=32

Bit(s)	Measurement	Contents
1-8	spare	

|1|2|3|4|5|6|7|8| EPD Subcommutated Housekeeping S.I.=33

Bit(s)	Measurement	Contents
1-8	+60 volts bias	

|1|2|3|4|5|6|7|8| EPD Subcommutated Housekeeping S.I.=34

Table A2.6.1 Subcommutated Analog Housekeeping (bit 1 is MSB)

Bit(s)	Measurement	Contents
1	power switch status byte #1	0=LEMMS amp 8 (E2) off 1=LEMMS amp 8 (E2) on
2	power switch status byte #1	0=LEMMS amp 7 (D) off 1=LEMMS amp 7 (D) on
3	power switch status byte #1	0=LEMMS amp 6 (C) off 1=LEMMS amp 6 (C) on
4	power switch status byte #1	0=LEMMS amp 5 (E1) off 1=LEMMS amp 5 (E1) on
5	power switch status byte #1	0=LEMMS amp 4 (A) off 1=LEMMS amp 4 (A) on
6	power switch status byte #1	0=LEMMS amp 3 (F2) off 1=LEMMS amp 3 (F2) on
7	power switch status byte #1	0=LEMMS amp 2 (F1) off 1=LEMMS amp 2 (F1) on
8	power switch status byte #1	0=LEMMS amp 1 (B) off 1=LEMMS amp 1 (B) on

|1|2|3|4|5|6|7|8| EPD Subcommutated Housekeeping S.I.=35

1-8	autocalibrator index # 6	binary number identifies S.I.=37 contents

|1|2|3|4|5|6|7|8| EPD Subcommutated Housekeeping S.I.=36

1-8	autocalibrator index voltage #6	0 to 5.1 volts

|1|2|3|4|5|6|7|8| EPD Subcommutated Housekeeping S.I.=37

1-8	spare	

|1|2|3|4|5|6|7|8| EPD Subcommutated Housekeeping S.I.=38

1-8	spare	

|1|2|3|4|5|6|7|8| EPD Subcommutated Housekeeping S.I.=39

Table A2.6.1 Subcommutated Analog Housekeeping (bit 1 is MSB)

Bit(s)	Measurement	Contents
1-8	Log amp. temperature	-171 to 69 deg. C

EPD Subcommutated Housekeeping S.I.=40

Bit(s)	Measurement	Contents
1	spare	
2	power switch status byte #2	0=calibrator off 1=calibrator on
3	power switch status byte #2	0=PHA off 1=PHA on
4	power switch status byte #2	0=TOF off 1=TOF on
5	power switch status byte #2	0=CMS electronics off 1=CMS electronics on
6	power switch status byte #2	0=detector bias normal 1=detector bias high
7	power switch status byte #2	0=TOVR RL off 1=TOVR RL on
8	power switch status byte #2	0=LEMMS A detector bias off 1=LEMMS A detector bias on (+60 V)

EPD Subcommutated Housekeeping S.I.=41

Bit(s)	Measurement	Contents
1-8	autocalibrator index # 7	binary number identifies S.I.=43 contents

EPD Subcommutated Housekeeping S.I.=42

Bit(s)	Measurement	Contents
1-8	autocalibrator AGC voltage #7	0 to 5.1 volts

EPD Subcommutated Housekeeping S.I.=43

Bit(s)	Measurement	Contents
1-8	spare	

EPD Subcommutated Housekeeping S.I.=44

Bit(s)	Measurement	Contents
1-8	spare	

EPD Subcommutated Housekeeping S.I.=45

Bit(s)	Measurement	Contents
1-8	-15 volts power	

EPD Subcommutated Housekeeping S.I.=46

Table A2.6.1 Subcommutated Analog Housekeeping (bit 1 is MSB)

Bit(s)	Measurement	Contents
1	power switch status byte #3	0=LEMMS -10 V power off 1=LEMMS -10 V power on
2	power switch status byte #3	0=motor off 1=motor on
3	power switch status byte #3	0=motor RAM normal 1=motor RAM exchanged
4	power switch status byte #3	0=motor controller in normal mode 1=motor controller in memory load mode
5	power switch status byte #3	0=motor controller running 1=motor controller reset
6	spare	
7	power switch status byte #3	0=LEMMS E11 thresh. norm 1=LEMMS E11 thresh. high
8	power switch status byte #3	0=LEMMS A1 thresh. norm. 1=LEMMS A1 thresh. high

|1|2|3|4|5|6|7|8| EPD Subcommutated Housekeeping S.I.=47

Bit(s)	Measurement	Contents
1-8	autocalibrator index # 8	binary number identifies S.I.=49 contents

|1|2|3|4|5|6|7|8| EPD Subcommutated Housekeeping S.I.=48

Bit(s)	Measurement	Contents
1-8	autocalibrator AGC voltage #8	0 to 5.1 volts

|1|2|3|4|5|6|7|8| EPD Subcommutated Housekeeping S.I.=49

Bit(s)	Measurement	Contents
1-8	upper alarm threshold for EPD input current	

|1|2|3|4|5|6|7|8| EPD Subcommutated Housekeeping S.I.=50

Bit(s)	Measurement	Contents
1-8	lower alarm threshold for EPD input current	

|1|2|3|4|5|6|7|8| EPD Subcommutated Housekeeping S.I.=51

Bit(s)	Measurement	Contents
1-8	+10 volts power	

|1|2|3|4|5|6|7|8| EPD Subcommutated Housekeeping S.I.=52

Table A2.6.1 Subcommutated Analog Housekeeping (bit 1 is MSB)

Bit(s)	Measurement	Contents
1	power switch status byte # 4	0=TOF logical condition on (TOVR=0) 1=TOF logical condition off (TOVR=1)
2	power switch status byte #4	0=VITO enable 1=VITO override
3	power switch status byte #4	0=JA00 off 1=JA00 on
4	power switch status byte #4	0=CMS analog L off 1=CMS analog L on
5	power switch status byte #4	0=CMS analog Jc off 1=CMS analog Jc on
	power switch status byte #4	0=CMS analog Jb off 1=CMS analog Jb on
7	power switch status byte #4	0=CMS analog Ja off 1=CMS analog Ja on
8	power switch status byte #4	0=CMS prime select off 1=CMS prime select on

|1|2|3|4|5|6|7|8| EPD Subcommutated Housekeeping S.I.=53

Bit(s)	Measurement	Contents
1-8	autocalibrator index #9	binary number identifies S.I.=55 contents

|1|2|3|4|5|6|7|8| EPD Subcommutated Housekeeping S.I.=54

Bit(s)	Measurement	Contents
1-8	autocalibrator AGC voltage #9	0 to 5.1 volts

|1|2|3|4|5|6|7|8| EPD Subcommutated Housekeeping S.I.=55

Bit(s)	Measurement	Contents
1-8	upper alarm threshold for EPD motor temp.	

|1|2|3|4|5|6|7|8| EPD Subcommutated Housekeeping S.I.=56

Bit(s)	Measurement	Contents
1-8	lower alarm threshold for EPD motor temp.	

|1|2|3|4|5|6|7|8| EPD Subcommutated Housekeeping S.I.=57

Bit(s)	Measurement	Contents
1-8	+6 volts power	

|1|2|3|4|5|6|7|8| EPD Subcommutated Housekeeping S.I.=58

Table A2.6.1 Subcommutated Analog Housekeeping (bit 1 is MSB)

Bit(s)	Measurement	Contents
1-8	spare	

EPD Subcommutated Housekeeping S.I.=59

Bit(s)	Measurement	Contents
1-8	autocalibrator index #10	binary number identifies S.I.=61 contents

EPD Subcommutated Housekeeping S.I.=60

Bit(s)	Measurement	Contents
1-8	autocalibrator index voltage #10	0 to 5.1 volts

EPD Subcommutated Housekeeping S.I.=61

Bit(s)	Measurement	Contents
1-8	upper alarm threshold for LEMMS telescope temperature	

EPD Subcommutated Housekeeping S.I.=62

Bit(s)	Measurement	Contents
1-8	lower alarm threshold for LEMMS telescope temperature	

EPD Subcommutated Housekeeping S.I.=63

Bit(s)	Measurement	Contents
1-8	+3 volts power	

EPD Subcommutated Housekeeping S.I.=64

Bit(s)	Measurement	Contents
1-7	spare	
8	Internal Monitor Status	0=Disabled 1=Enabled

EPD Subcommutated Housekeeping S.I.=65

Bit(s)	Measurement	Contents
1-8	autocalibrator index #11	binary number identifies S.I.=67 contents

EPD Subcommutated Housekeeping S.I.=66

Bit(s)	Measurement	Contents
1-8	autocalibrator AGC voltage #11	0 to 5.1 volts

EPD Subcommutated Housekeeping S.I.=67

Table A2.6.1 Subcommutated Analog Housekeeping (bit 1 is MSB)

Bit(s)	Measurement	Contents
1-8	upper alarm threshold for CMS telescope temperature	

1	2	3	4	5	6	7	8

EPD Subcommutated Housekeeping S.I.=68

Bit(s)	Measurement	Contents
1-8	lower alarm threshold for CMS telescope temperature	

1	2	3	4	5	6	7	8

EPD Subcommutated Housekeeping S.I.=69

Bit(s)	Measurement	Contents
1-8	-3 volts power	

1	2	3	4	5	6	7	8

EPD Subcommutated Housekeeping S.I.=70

Bit(s)	Measurement	Contents
1-8	spare	

1	2	3	4	5	6	7	8

EPD Subcommutated Housekeeping S.I.=71

Bit(s)	Measurement	Contents
1-8	autocalibrator index #12	binary number identifies S.I.=73 contents

1	2	3	4	5	6	7	8

EPD Subcommutated Housekeeping S.I.=72

Bit(s)	Measurement	Contents
1-8	autocalibrator AGC voltage #12	0 to 5.1 volts

1	2	3	4	5	6	7	8

EPD Subcommutated Housekeeping S.I.=73

Bit(s)	Measurement	Contents
1-8	upper alarm threshold for main electronics temperature	

1	2	3	4	5	6	7	8

EPD Subcommutated Housekeeping S.I.=74

Bit(s)	Measurement	Contents
1-8	lower alarm threshold for main electronics temperature	

1	2	3	4	5	6	7	8

EPD Subcommutated Housekeeping S.I.=75

Bit(s)	Measurement	Contents
1-8	-6 volts power	

1	2	3	4	5	6	7	8

EPD Subcommutated Housekeeping S.I.=76

Table A2.6.1 Subcommutated Analog Housekeeping (bit 1 is MSB)

Bit(s)	Measurement	Contents
1-8	spare	

|1|2|3|4|5|6|7|8| EPD Subcommutated Housekeeping S.I.=77

Bit(s)	Measurement	Contents
1-8	autocalibrator index #13	binary number identifies S.I.=79 contents

|1|2|3|4|5|6|7|8| EPD Subcommutated Housekeeping S.I.=78

Bit(s)	Measurement	Contents
1-8	autocalibrator AGC voltage #13	0 to 5.1 volts

|1|2|3|4|5|6|7|8| EPD Subcommutated Housekeeping S.I.=79

Bit(s)	Measurement	Contents
1-8	upper alarm threshold + 10 volts power	

|1|2|3|4|5|6|7|8| EPD Subcommutated Housekeeping S.I.=80

Bit(s)	Measurement	Contents
1-8	lower alarm threshold + 10 volts power	

|1|2|3|4|5|6|7|8| EPD Subcommutated Housekeeping S.I.=81

Bit(s)	Measurement	Contents
1-8	-10 volts power	

|1|2|3|4|5|6|7|8| EPD Subcommutated Housekeeping S.I.=82

Bit(s)	Measurement	Contents
1-8	spare	

|1|2|3|4|5|6|7|8| EPD Subcommutated Housekeeping S.I.=83

Bit(s)	Measurement	Contents
1-8	autocalibrator index #14	binary number identifies S.I.=85 contents

|1|2|3|4|5|6|7|8| EPD Subcommutated Housekeeping S.I.=84

Bit(s)	Measurement	Contents
1-8	autocalibrator AGC voltage #14	0 to 5.1 volts

|1|2|3|4|5|6|7|8| EPD Subcommutated Housekeeping S.I.=85

Table A2.6.1 Subcommutated Analog Housekeeping (bit 1 is MSB)

Bit(s)	Measurement	Contents
1	spare	
2	PHA control byte output clear	0=PHA output clear 1=PHA output normal
3	PHA control byte override	0=priority normal 1=priority override
4	PHA control byte reset	0=PHA normal 1=PHA reset
5-6	PHA control byte lemms flavor/priority	2 bit LEMMS select 0=A, 1=E, 2=F (or if bit 3=1, then this determines priority, 0=I, 1=II, 2=III, 3=IV)
7	PHA control byte read active	0=P read active 1=P read inactive
8	PHA control byte mode	0=LEMMS mode 1=CMS mode

|1|2|3|4|5|6|7|8| EPD Subcommutated Housekeeping S.I.=86

Bit(s)	Measurement	Contents
1-8	spare	

|1|2|3|4|5|6|7|8| EPD Subcommutated Housekeeping S.I.=87

Bit(s)	Measurement	Contents
1-8	spare	

|1|2|3|4|5|6|7|8| EPD Subcommutated Housekeeping S.I.=88

Bit(s)	Measurement	Contents
1-8	spare	

|1|2|3|4|5|6|7|8| EPD Subcommutated Housekeeping S.I.=89

Bit(s)	Measurement	Contents
1-8	spare	

|1|2|3|4|5|6|7|8| EPD Subcommutated Housekeeping S.I.=90

A2.6.4 Digital Status. The contents of the Digital Status section is described in Table A2.6.2.

Table A2.6.2 Digital Status (MSB is bit 1)

Bit(s)	Measurement	Contents
1	scan error	0=no error detected 1=error detected
2	fast scan abort flag	0=normal 1=fast scan aborted
3	emergency count flag	0=normal 1=means byte 2 bits 4-8 are now an emergency count number MOD 32
4	motor direction indicator	0=counter clockwise 1=clockwise
5	motor centerline indicator	0=motor not on center-line 1=motor on centerline
6-8	motor position code	Sector 0-7

|1|2|3|4|5|6|7|8| EPD Byte #2

Bit(s)	Measurement	Contents
1-8	memory dump	8 bits of memory

|1|2|3|4|5|6|7|8| EPD Byte #3

Bit(s)	Measurement	Contents
1-8	memory dump cursor	8 LSB's of memory dump address (8 MSB are in subcommutated data, 16 bits total)

|1|2|3|4|5|6|7|8| EPD Byte #4

Bit(s)	Measurement	Contents
1-8	commands executed	number of commands executed MOD 256 since last power on.

|1|2|3|4|5|6|7|8| EPD Byte #5

Bit(s)	Measurement	Contents
1-8	packet parity	exclusive-OR of all other bytes in packet

|1|2|3|4|5|6|7|8| EPD Byte #6

Bit(s)	Measurement	Contents
1-8	command op code	operation code of last command executed

|1|2|3|4|5|6|7|8| EPD Byte #7

Table A2.6.2 Digital Status (MSB is bit 1)

Bit(s)	Measurement	Contents
1	alternating mode	0=normal CMS mode 1=CMS alternating mode
2	power monitor flag	0=normal 1=EPD power recently interrupted
3	bus adaptor parity error flag	0=normal 1=parity error detected
4	Resynchronization flag	0=normal 1=EPD recently resynced to CDS
5	cease scan flag	0=normal 1=motor controller has entered "cease scan" mode
6	motor in motion flag	0=normal 1=motor was in motion during this packet
7	singles/background flag	0=S/B format L 1=S/B formats J or J'
8	J/J' indicator	0=CMS mode J 1=CMS mode J'

|1|2|3|4|5|6|7|8| EPD Byte #8

Bit(s)	Measurement	Contents
1	Modulo 2 counter	0=even packet 1=odd packet
2-4	Modulo 7 counter	increments every packet
5-8	Modulo 13 counter	increments when Mod 7 counter resets*

|1|2|3|4|5|6|7|8| EPD Byte #9

* [7(MOD 13)+(MOD 7)+2] modulo91=SCLK Mod 91

A2.6.5 CMS PHA/LEMMS PHA Data. The contents of the CMS PHA/LEMMS PHA Data section can be either CMS PHA data or LEMMS PHA data. The timing of when the data is CMS PHA or LEMMS PHA is shown in Table A2.6.3

Table A2.6.3 SI vs. CMS PHA/
LEMMS PHA section contents

MOD 91	Contents
2	LEMMS PHA data
9	LEMMS PHA data
16	LEMMS PHA data
23	LEMMS PHA data
30	LEMMS PHA data
37	LEMMS PHA data
44	LEMMS PHA data
51	LEMMS PHA data
58	LEMMS PHA data
65	LEMMS PHA data
72	LEMMS PHA data
79	LEMMS PHA data
86	LEMMS PHA data
All Others	CMS PHA data

The CMS PHA data section contains information on Composition Measurement System (CMS) Pulse Height Analyzer (PHA) data. LEMMS PHA data contains information on Low Energy Magnetospheric Measurement System (LEMMS) PHA spectrum data. When this section contains CMS PHA data, the contents are described in Table A2.6.4, which refers to one event.

Thirteen times throughout one major frame (i.e., when the MOD 91 counter registers 2, 9, 16, 23, 30, 37, 44, 51, 58, 65, 72, 79, and 86) the 12 bytes (96 bits) of CMS PHA data will be replaced by LEMMS PHA data. The 12 bytes, in addition to the 35 bytes of LEMMS PHA found in bits 169 to 208 of each of the 7 packets of EPD telemetry form one complete 47-byte LEMMS PHA spectrum. The 47 byte LEMMS PHA spectrum will be sorted into energy bins (or bin numbers), which are given in Table A2.6.6.

Table A2.6.4 CMS PHA Data (bit 1 is MSB)

Bit(s)	Measurement	Contents
1-8	CMS PHA delta EJ #1	

|1|2|3|4|5|6|7|8| EPD CMS PHA Data, byte 10

Bit(s)	Measurement	Contents
1-8	CMS PHA delta EK #1	

|1|2|3|4|5|6|7|8| EPD CMS PHA Data, byte 11

Table A2.6.4 CMS PHA Data (bit 1 is MSB)

EPD CMS PHA Data, byte 12

Bit(s)	Measurement	Contents
1-8	CMS PHA TOF #1	

EPD CMS PHA Data, byte 13

Bit(s)	Measurement	Contents
1-2	J ID #1	0=Jc 1=Jb 2=N/A 3=Ja
3-4	last transmitted priority #1	0=priority 1 1=priority 2 2=priority 3 3=priority 4
5-8	CMS PHA rate channel code #1	0=CM5 1=CN0 2=CN1 3=CH5 4=CH2 5=CH3 6=CH4 7=N/A 8=CM2 9=CM3 10=CM4 11=N/A 12=C ALPHA 2 13=C ALPHA 3 14=C ALPHA 4 15=N/A

EPD CMS PHA Data, byte 14

Bit(s)	Measurement	Contents
1-8	CMS PHA delta EJ #2	

EPD CMS PHA Data, byte 15

Bit(s)	Measurement	Contents
1-8	CMS PHA delta EK #2	

EPD CMS PHA Data, byte 16

Bit(s)	Measurement	Contents
1-8	CMS PHA TOF #2	

Table A2.6.4 CMS PHA Data (bit 1 is MSB)

EPD CMS PHA Data, byte 17

Bit(s)	Measurement	Contents
1-2	J ID #2	0=Jc 1=Jb 2=N/A 3=Ja
3-4	last transmitted priority #2	0=priority 1 1=priority 2 2=priority 3 3=priority 4
5-8	CMS PHA rate channel code #2	0=CM5 1=CN0 2=CN1 3=CH5 4=CH2 5=CH3 6=CH4 7=N/A 8=CM2 9=CM3 10=CM4 11=N/A 12=C ALPHA 2 13=C ALPHA 3 14=C ALPHA 4 15=N/A

EPD CMS PHA Data, byte 18

Bit(s)	Measurement	Contents
1-8	CMS PHA delta EJ #3	

EPD CMS PHA Data, byte 19

Bit(s)	Measurement	Contents
1-8	CMS PHA delta EK #3	

EPD CMS PHA Data, byte 20

Bit(s)	Measurement	Contents
1-8	CMS PHA TOF #3	

Table A2.6.4 CMS PHA Data (bit 1 is MSB)

Bit(s)	Measurement	Contents
1-2	J ID #3	0=Jc 1=Jb 2=N/A 3=Ja
3-4	last transmitted priority #3	0=priority 1 1=priority 2 2=priority 3 3=priority 4
5-8	CMS PHA rate channel code #3	0=CM5 1=CN0 2=CN1 3=CH5 4=CH2 5=CH3 6=CH4 7=N/A 8=CM2 9=CM3 10=CM4 11=N/A 12=C ALPHA 2 13=C ALPHA 3 14=C ALPHA 4 15=N/A

\|1\|2\|3\|4\|5\|6\|7\|8\| EPD CMS PHA Data, byte 21

A2.6.6 LEMMS PHA Data. The LEMMS PHA data section contains an additional 5 (8 bit) bytes of LEMMS PHA data. The contents of this section is shown in Table A2.6.5.

Table A2.6.5 LEMMS PHA Data (bit 1 is MSB)

Bit(s)	Measurement	Contents
1-3	LEMMS PHA spectrum element #1 exponent	if exponent=7, then value=mantissa, if not, value=(mantissa+32)$\cdot 2^{exp}$
4-8	LEMMS PHA spectrum element #1 mantissa	

\|1\|2\|3\|4\|5\|6\|7\|8\| EPD LEMMS PHA Data, byte 22

Table A2.6.5 LEMMS PHA Data (bit 1 is MSB)

Bit(s)	Measurement	Contents
1-3	LEMMS PHA spectrum element #2 exponent	if exponent=7, then value=mantissa, if not, value=(mantissa+32)·2^{exp}
4-8	LEMMS PHA spectrum element #2 mantissa	

|1|2|3|4|5|6|7|8|

EPD LEMMS PHA Data, byte 23

1-3	LEMMS PHA spectrum element #3 exponent	if exponent=7, then value=mantissa, if not, value=(mantissa+32)·2^{exp}
4-8	LEMMS PHA spectrum element #3 mantissa	

|1|2|3|4|5|6|7|8|

EPD LEMMS PHA Data, byte 24

1-3	LEMMS PHA spectrum element #4 exponent	if exponent=7, then value=mantissa, if not, value=(mantissa+32)·2^{exp}
4-8	LEMMS PHA spectrum element #4 mantissa	

|1|2|3|4|5|6|7|8|

EPD LEMMS PHA Data, byte 25

1-3	LEMMS PHA spectrum element #5 exponent	if exponent=7, then value=mantissa, if not, value=(mantissa+32)·2^{exp}
4-8	LEMMS PHA spectrum element #5 mantissa	

|1|2|3|4|5|6|7|8|

EPD LEMMS PHA Data, byte 26

Table A2.6.6. GALILEO EPD LEMMS PHA Bin Assignments

Packet Identifier (Modulo 7 counter)	Byte Number	LEMMS PHA Bin Number
0	10	1
0	11	2
0	12	3
0	13	4
0	14	5
0	15	6
0	16	7
0	17	8
0	18	9
0	19	10
0	20	11
0	21	12
0	22	13
0	23	14
0	24	15
0	25	16
0	26	17
1	22	18
1	23	19
1	24	20
1	25	21
1	26	22
2	22	23
2	23	24
2	24	25
2	25	26
2	26	27
3	22	28
3	23	29
3	24	30
3	25	31
3	26	32
4	22	33
4	23	34
4	24	35
4	25	36
4	26	37
5	22	38
5	23	39
5	24	40
5	25	41
5	26	42
6	22	43
6	23	44
6	24	45
6	25	46
6	26	47

A2.6.7 Rate Channel Data. The Rate Channel Data section contains 40 rate channels, 10 bits each, of CMS and LEMMS sensor data. The particular rate channel involved depends on the Mod 2 counter described in Table A2.6.2. Table A2.6.7 shows the contents of the Rate Channel section for odd and even packets.

EPD rate channel accumulators are 10 bits log compressed from 24 bits. The log compression algorithm can be stated as follows:

Given a 24 bit binary integer with MSB on the left and LSB on the right, find the most significant "1". The number of bits to the right of the most significant "1", minus six, is the exponent. If this exponent value is negative, or if the original number itself is zero, set the exponent to 15, and use the six least significant bits of the original 24 bit number as the mantissa. If this is not the case, use the six bits immediately to the right of the most significant "1" as the mantissa.

The log decompression algorithm can be stated as follows:

Given the 10 bit log compressed rate channel data, the first 4 bits are the exponent, and the last 6 bits are the mantissa. If the exponent = 15, then the value = mantissa; if not then the value = $(\text{mantissa} + 64) \cdot 2^{\text{exp}}$.

Table A2.6.7 EPD Rate Channel Data

Bits	Even Packet[1]			Odd Packet[2]		
	CMS J	LEMMS	CMS J'	CMS J S/B J	LEMMS S/B L	CMS J' S/B J'
209-218		E01			E03	
219-228		E11			E13	
229-238		A01			A03	
239-248		A11			A13	
249-258		A21			A22	
259-268		E21			E22	
269-278		E31			E32	
279-288		F01			F02	
289-298		F11			F12	
299-308		A31			A32	
309-318		A41			A42	
319-328		A51			A52	
329-338		A61			A62	
339-348		A71			A72	
349-358		F21			F22	
359-368		F31			F32	
369-378	CE2		CE2P	CM3		CM3P
379-388	CE3		CE3P	CM4		CM4P
389-398	CE1		CE1P	CM5		CM5P
399-408	CP1		CP1P	CN1		CN1P
409-418		E02			E04	
419-428		E12			E14	
429-438		A02			A04	
439-448		A12			A14	
449-458	CP2		CP2P	CH2		CH2P
459-468	CP3		CP3P	CH3		CH3P
469-478	CH0		CH0P	CH4		CH4P
479-488	CH1		CH1P	CH5		CH5P
489-498		A81		EB1	KS	KP
499-508		DC0		EB2	JB	EB2
509-518		DC1		FB2	FB1	FB1
519-528		DC2		AS	AS	AS
529-538		DC3		CA0		CA0P
539-548		B01		CA2		CA2P
549-558		B11		BS	LS	BS
559-568		B21		CS	JA	JAP
569-578	CA1		CA1P	CM0		CM0P
579-588	CA3		CA3P	CM2		CM2P
589-598	CA4		CA4P	CN0		CN0P
599-608	CM1		CM1P	DS	JC	JCP

NOTES:

1. If the LEMMS column is blank, use the CMS J column if the J/J' indicator is zero, otherwise use the CMS J' column.
2. If the LEMMS S/B L column is blank, treat as in footnote 1. If all three columns contain names, this is a Singles/Background channel. Use the LEMMS S/B L column if the Singles/Background Flag is zero, otherwise treat the same as in footnote 1.

A2.6A HEAVY ION COUNTER SUBSYSTEM TELEMETRY

These paragraphs describe the format and content of the HIC output.

A2.6A.1 HIC Packet. The schematic of the HIC packet is shown in Figure A2.6A.1. 3 LRS Frames are required to transport 1 HIC Packet.

Title	1st Rate Area	1st Tag Word	1st PHA Area	1st CRC Word	2nd Rate Area	2nd Tag Word	2nd PHA Area	2nd CRC Word	3rd Rate Area	Status Word	3rd Tag Word	3rd PHA Area	3rd CRC Word
Data Offset	0	36	48	84	96	132	144	180	192	216	228	240	276
Bits/Packet	36	12	36	12	36	12	36	12	24	12	12	36	12
Description	A2.6A.3	A2.6A.4	A2.6A.5	A2.6A.6	A2.6A.3	A2.6A.4	A2.6A.5	A2.6A.6	A2.6A.3	A2.6A.7	A2.6A.4	A2.6A.5	A2.6A.6

Figure A2.6A.1 HIC Packet

A2.6A.2 Instrument Synchronicity. There are 30 1/3 packets per RIM. The HIC Packet can start in any LRS frame. HIC Packet synchronization is achieved by searching for a 1, 2, 3, 12, 13, or 14 in the 4 MSB of the 3rd word of any LRS HIC allocation. This would identify a status word.

The Synchronization Index is the first 4 bits of the status word (see Table A2.6A.7). The Synchronization Index applies to the subcommutated Rate Channels, and the subcommutated status word.

A2.6A.3 Rate Channel Sections 1, 2, and 3. These three sections contain 12 bit log compressed rate channel data. The first section contains three (3) rate channels, as shown in Table A2.6A.1.

Table A2.6A.1 Rate Channel Section 1

Word	Rate Channel
1	DUBL, Double Event - detectors LE1 and LE2 in LET E telescope
2	TRPL, Triple Event - detectors LE1, LE2, and LE3 in LET E telescope
3	WDSTP, Wide Stopping Event - detectors LE2, LE3, and LE4 in LET E telescope

The second section contains three (3) rate channels, as shown in Table A2.6A.2.

Table A2.6A.2 Rate Channel Section 2

Word	Rate Channel
1	WDPEN, Wide Penetrating Event - detectors LE2, LE3, LE4 and LE5 in LET E telescope
2	LETB, Any Event in LET B telescope
3	LE 1, Any Firing of the LE Detector in LET E telescope

The third section contains two (2) subcommutated rate channels, as shown in Table A2.6A.3.

Table A2.6A.3 Subcommutated Rate Channel Section

S.I.	1st. Word LE Singles	2nd. Word LB Singles
0	SB	SLB
1	SB	SLB
2	SB	SLB
3	SB	LBTRP
4	SB	SLB
5	SB	SLB
6	SB	SLB
7	SB	SLB
8	LE5	LB1
9	LE3	LB2
10	LE4	LB3
11	LE2	LB4
12	SB	SLB
13	SB	SLB
14	SB	SLB
15	SB	SLB

The acronyms used in Table A2.6A.3 are defined as follows:

- SB - An event triggering the slant discriminators in telescope LET E.
- SLB - An event triggering the slant discriminators in telescope LET B.
- LBTRP - An event triggering the first 3 detectors in the LET B telescope.
- LE (n) - Any triggering of detector (n) in the LET E telescope.
- LB (n) - Any triggering of detector (n) in the LET B telescope.

The algorithms for the rate channel data compression and reconstruction are shown in Figure A2.6A.2.

Compression

MSB	N-1	LSB		MSB	X	C	LSB
1		24	------>	1	5 | 6		12
Binary Input Word				HIC Rate Channel Word			

N=0 to 16,777,214
(Where N is the number of counts)

X=5 bit power of 2 exponent
C=7 bit fraction (1 bit hidden).

Algorithm:

for N=0	X=0 (dec), C=127 (dec)	
for N=1	X=31, C=0	
for N>1	X=Integer[23-log2 (N-1)],	C=Integer[(N-1) * 2^{X-16}-128]

Decompression

X	C			N
1	5 | 6	12	------>	1 ... 24
HIC Rate Channel Word				Binary Input Word

Algorithm:

for X=0 (dec)	N=0 (dec)
for X=31	N=1
else	N=[(128+C) *2^{16-X}]+1

Figure A2.6A.2. Rate channel compression/decompression algorithm.

A2.6A.4 PHA Areas 1, 2, and 3. These three sections contain unsigned 12 bit numbers representing single sizes from various detectors. Each section contains three (3) 12 bit words. the contents of each word are determined by the tag word described in paragraph A2.6A.5. Each tag word describes the immediately preceding PHA Area. Table A2.6A.4 describes the contents of these areas.

Table A2.6A.4 PHA Words

Word	Contents* LET E telescope	LET B telescope
1	PHA 3 - LE3	LB3
2	PHA 2 - LE1, if bit 1 of Tag word=0 (LE4+LE5) if bit 1 of Tag word=1	LB2
3	PHA 1 - LE2	LB1

*Note - if no event is available, all zero's are telemetered.

A2.6A.5 Tag Word 1, 2, and 3. The tag words describe the contents of the PHA Areas described above. Bit 9 of the Tag words describes whether the data was from the LET E or LET B telescope. Table A2.6A.5 describes the tag word contents for the LET E telescope, and Table A2.6A.6 describes the Tag word contents for the LET B telescope.

Table A2.6A.5 HIC Tag Word (MSB is Bit 1) for LET E (Bit 9=0)

Bit(s)	Measurement	Contents
1	LE4 discriminator	0=disc. did not fire 1=disc. did fire
2	LE1 discriminator	0=disc. did not fire 1=disc. did fire
3	LE5 discriminator	0=disc. did not fire 1=disc. did fire
4	LE3 discriminator	0=disc. did not fire 1=disc. did fire
5	SB discriminator	0=disc. did not fire 1=disc. did fire
6	LE2 discriminator	0=disc. did not fire 1=disc. did fire
7	spare	0
8	High Gain status	0=normal, low gain 1=high gain
9	LET E/LET B	0 (LET E)
10	DUBL mode	0=not in double mode 1=in double mode
11	block ID	1 (not used)
12	caution flag	0=good event 1=compromised event

|1|2|3|4|5|6|7|8|9|10|11|12|

Tag word for LET E telescope

Table A2.6A.6 HIC Tag Word (MSB is Bit 1) for LET B (Bit 9=1)

Bit(s)	Measurement	Contents
1	SLB discriminator	0=disc. did not fire 1=disc. did fire
2	LB3 discriminator	0=disc. did not fire 1=disc. did fire
3	LB2 discriminator	0=disc. did not fire 1=disc. did fire
4	LB1 discriminator	0=disc. did not fire 1=disc. did fire
5	spare	0
6	LB2 terms	0=normal 1=term deleted
7	LB3 terms	0=normal 1=term deleted
8	spare	0
9	LET E/LET B	1 (LET B)
10	spare	0
11	block ID	1=not used
12	caution flag	0=good event 1=compromised event

|1|2|3|4|5|6|7|8|9|10|11|12|

Tag word for LET B telescope

A2.6A.6 CRC Words 1, 2, and 3. The CRC words are a cyclic Redundancy check over the 84 bits preceding each word. The first 8 bits contain the CRC word, with the last four bits fixed as zero's. The algorithm used for the checksum is shown in Figure A2.6A.3.

```
initialize 84-element array x() to zero
loop for n = 1 to 84
   input = nth bit of 84-bit data stream
   x(0) = x(8) XOR input
   x(8) = x(7) XOR x(0)
   x(7) = x(6) XOR x(0)
   x(6) = x(5)
   x(5) = x(4)
   x(4) = x(3)
   x(3) = x(2)
   x(2) = x(1)
   x(1) = x(0)
   end of loop
  CRC = 128*x(8) + 64*x(7) + 32*x(6) + 16*x(5) + 8*x(4) +
                                          4*x(3) + 2*x(2) + x(1)
```

Figure A2.6A.3 CRC Algorithm

A2.6A.7 Status Word. The contents of the status word is shown in Table A2.6A.7

Table A2.6A.7 Digital Status (Bit 1 is MSB)

Bit(s)	Measurements	Contents
1-4	synchronization index	0-15 (dec)
5-12	subcommutated status	see Tables A2.6A.8 to A2.6A.13

|1|2|3|4|5|6|7|8|9|10|11|12| Tag word for LET B telescope

The subcommutated status is valid only for the Synchronization Index equaling 0, 2, 6, 8, 12, and 13. The contents are shown in Tables A2.6A.8 through A2.6A.13 respectively.

Table A2.6A.10 Subcommutated Status (SI=0)

Bit(s)	Measurement	Contents
5-6	not used	0
7	High Voltage Enable Status	0=high voltage off 1=high voltage on
8	High Gain status	0=normal gain 1=high gain
9	not used	
10-12	Calibration status	000=cal off,or 1st state 001=2nd state 010=3rd state 011=4th state 100=5th state 101=6th state 110=7th state 111=8th state

|5|6|7|8|9|10|11|12| subcommutated status for S.I.=0

Table A2.6A.10 Subcommutated Status (SI=2)

Bit(s)	Measurement	Contents
5	LE1 Pre-AMP Power Status	0=Power on 1=Power off
6	LE2 Pre-Amp Power Status	0=Power on 1=Power off
7	LE3 Pre-Amp Power Status	0=Power on 1=Power off
8	LE4 Pre-Amp Power Status	0=Power on 1=Power off
9	not used	
10	LE5 Pre-Amp Power Status	0=Power on 1=Power off
11-12	not used	

|5|6|7|8|9|10|11|12| subcommutated status for S.I.=2

Table A2.6A.10 Subcommutated Status (SI=6)

Bit(s)	Measurement	Contents
5-6	not used	0
7	WDSTP mode	0=normal 1=mode deleted
8	TRPL mode	0=normal 1=mode deleted
9	not used	0=normal 1=mode deleted
10	DUBL mode	0=normal 1=mode deleted
11	LET B	0=normal 1=mode deleted
12	WDPEN mode	0=normal 1=mode deleted

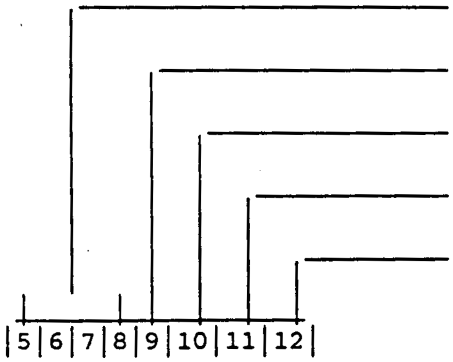
|5|6|7|8|9|10|11|12| subcommutated status for S.I.=6

Table A2.6A.11 Subcommutated Status (SI=8)

Bit(s)	Measurement	Contents
5	LB3 terms	0=normal 1=term deleted
6	LB2 terms	0=normal 1=term deleted
7	not used	0
8	LE3 terms	0=normal 1=term deleted
9	LE4 terms	0=normal 1=term deleted
10	LE1/B2 terms	0=normal 1=term deleted
11	LE2/B1 terms	0=normal 1=term deleted
12	LE1/A2 terms	0=normal 1=term deleted

|5|6|7|8|9|10|11|12| subcommutated status for S.I.=8

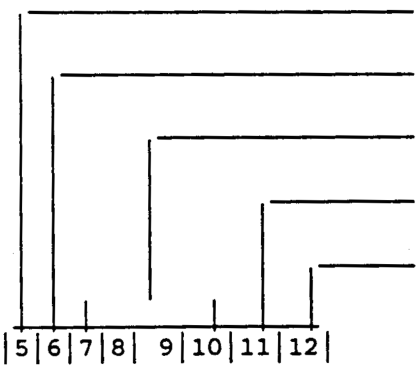
Table A2.6A.12 Subcommutated Status (SI=12)



Bit(s)	Measurements	Contents
5-8	not used	0
9	LB4 Pre-amp Power Status	0=power on 1=power off
10	LB3 Pre-amp Power Status	0=power on 1=power off
11	LB2 Pre-amp Power Status	0=power on 1=power off
12	LB1 Pre-amp Power Status	0=power on 1=power off

subcommutated status for S.I.=12

Table A2.6A.13 Subcommutated Status (SI=13)



Bit(s)	Measurements	Contents
5	redundant High Voltage command received	0=command not received 1=command received
6	Cal/Stim disable	0=normal 1=disabled
7-10	not used	0
11	Auto Gain command	0=auto gain not commanded 1=auto gain commanded
12	High Gain command	0=high gain not commanded 1=high gain commanded

subcommutated status for S.I.=13

A2.6A.8 Telemetry Mode Changes. Upon application of system power, the HIC shall configure itself to a state where only status telemetry is valid.

Commanded telemetry mode changes are processed once per minor frame. Mode changes will occur at the next RTI.

A2.6B EXTREME ULTRAVIOLET SUBSYSTEM TELEMETRY. These paragraphs describe the format and content of the EUV output.

A2.6B.1 EUV Spin Packet. The Galileo EUV spin packet is described in Table A2.6B.1.

A2.6B.2 Data System. The digital output shall consist of 12-8 bit words per telemetry request (minor frame). The word formats are described in the following sections. The data rate shall be 144 bits per second.

A2.6B.2.1 Digital Status. The first twelve bytes requested from the EUV by CDS at the start of each major frame shall consist of a fixed format packet of digital status. (see table A2.6B.2)

A2.6B.2.1.1 Synchronization Pattern. The first two bytes of the digital status packet are a fixed pattern meant to give a 'synchronization' pattern should the microprocessor lose spacecraft time. This pattern is defined to be 7E (hex). (Chosen because the pixel at 7E is not used, so address data will never be 7E).

A2.6B.2.1.2 Discrete Digital Status Byte. This byte shall indicate the current mode of the EUV Channel. It uses one bit to indicate the current mode, three bits for the High Voltage control, or four status bits. Table A2.6B.2 describes this byte in more detail. This byte shall be a reflection of the most recently issued EUV Channel Command Signals. 35242

A2.6B.2.1.3 RIM Counter. These three bytes shall indicate the current major frame (RIM) counter. Its purpose here is to make the EUV telemetry packet self contained.

A2.6B.2.1.4 Sector Size Status. This byte should be a copy of the commanded sector size. It indicates the number of 20.8 millisecond periods per sector.

A2.6B.2.1.5 Number of Sectors Per Integration Period. This byte should be a copy of the commanded number of sectors.

A2.6B.2.1.6 Software Accumulators. Two separate buffers, each 16 bits wide, shall be updated internal to the EUV instrument. The first buffer contains registers for each of the sectors in the commanded mode. Each of these registers are incremented whenever a photon of any wavelength is detected within each sector. The second buffer contains 128 registers for each of the 128 pixels, and each register will be incremented whenever a photon is detected by its associated pixel, regardless of the sector. (See Figure A2.6B.1).

A2.6B.2.1.6.1 Sector Accumulator Address. This is the addres of the sector being read out in the next two bytes. This address will be set to zero whenever the EUV receives a new command. Otherwise it will simply roll modulo the commanded number of sectors.

A2.6B.2.1.6.2 Sector Accumulator Data. These two bytes are the number of photons accumulated in the sector addressed in the Sector Accumulator Address. These registers are cleared only upon microprocessor initialization.

A2.6B.2.1.6.3 Wavelength Integrator Address. This is the address of the next Pixel (wavelength) to be read out. Note that the actual integration bytes are part of the spin packet which occurs approximately three times per major frame, thus allowing the sector accumulator readout to more closely match the wavelength readout (Nominally there will be 25 or less sectors). These registers are also cleared only at microprocessor initialization.

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A2.6B.2.2 Spin Packets. The spin packets shall contain an 'FE' Hex sync pattern, two bytes of wavelength integration data, and two bytes containing the minor frame (MOD91) counter and RTI (MOD10) counter in which integration started for this revolution. These will be followed by a variable number of pixel address bytes indicating a photon has been detected in that particular pixel and sector.

A2.6B.2.2.1 Wavelength Integration Data. The second and third bytes of a Spin Packet contain the high order, then the low order, of the 16 bit accumulated data for the current pixel (as defined in the digital housekeeping packet).

A2.6B.2.2.2 Spin Integration Start Time. The fourth and fifth bytes of each spin packet contain the minor frame (MOD91) counter and RTI (MOD10) counter respectively, during which integration started on this revolution.

A2.6B.2.2.3 Pixel Address Information. In order to meet telemetry bandwidths, it has been decided to send the 7 bit address information down whenever a pixel detects a photon or background count. See Table A2.6B.1 for a description and discussion relating to the Spin Packets.

Table A2.6B.1. EUV Spin Packets Description

Bit* / Byte	MSB 1	2	3	4	5	6	7	8
1	0	1	1	1	1	1	1	0
2	0	1	1	1	1	1	1	0
3	FAST MUX	126 FLAG	SPIN BUFFER OVERFL	127 FLAG	Mode	HVPS MSB	HVPS	HVPS
4	RIM Counter MSByte							
5	RIM Counter							
6	RIM Counter LSByte							
7	Sector Size							
8	Number of Sectors							
9	Sector Accumulator Address							
10	Sector Accumulator Data (MSByte)							
11	Sector Accumulator Data (LSByte)							
12	Wavelength Integration Address							

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Table A2.6B.2. EUV Housekeeping TLM Format Descriptions

Byte	Bit (s)*	Description
1,2	1 - 8	Fiducial - These will each be 7E hex.
3	1	Fast Mux Mode 0 = Normal 1 step/RIM 1 = Fast Mux 1 step/4 minor frames
3	2	126 Flag - indicates whether pixel 126 has been active during the preceding major frame 0 = inactive 1 = active
3	3	Spin Buffer Overflow - indicates if data has been lost in the preceding major frame due to high count rates. 0 = no overflow 1 = overflow (data lost)
3	4	127 Flag - indicates whether pixel 127 has been active during the preceding frame. 0 = inactive 1 = active
3	5	EUV Channel Mode 0 = Pulse Integration Mode 1 = Pulse Counting Mode
3	6 - 8	EUV High Voltage Control 000 = High Voltage Off 001 - 111 = Discrete HV Steps
4	1 - 8	RIM Counter (MSByte) - This is a copy of the upper 8 bits of the 24 bit RIM Counter. It is included here to make the EUV TM Data self contained.
5	1 - 8	RIM Counter - This is the middle 8 bits of the 24 bit RIM Counter.
6	1 - 8	RIM Counter - This is the lower 8 bits of the 24 bit RIM Counter.
7	1 - 8	Sector Size - Indicates the number of 20.8 milliseconds period for each sector.

Table A2.6B. (Continued)

8	1 - 8	Number of Sectors - Indicates the number of sectors before integration starts.
9	1 - 8	Sector Integrator Address - Indicates the sector address of the Sector Data that follows in the next two bytes.
10,11	1 - 8	Sector Integrator Data - The accumulated number of photons of any detected wavelength in this sector since the last read-out. Byte 10 will be the μs byte.
12	1 - 8	Wavelength Integrator Address - Indicates wavelength address (pixel) of the integrate wavelength data that follows in the next spin packet.

*Bit numbering conventions are per GLL-3-290.

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A2.7 MAGNETOMETER SUBSYSTEM TELEMETRY

These paragraphs describe the format and content of the output of the Magnetometer Subsystem.

A2.7.1 MAG Packet. The schematic of a MAG Packet is shown in Figure A2.7.1. One packet is placed in each LRS frame.

Title	Instrument Status	1st Science Sample	2nd Science Sample	3rd Science Sample
Data Offset	0	16	64	112
Bits/packet	16	48	48	48
Description	A2.7.3	A2.7.4	A2.7.5	A2.7.6

Figure A2.7.1 MAG Packet

A2.7.2 Instrument Synchronicity. The contents of the MAG Packet can be uniquely determined from the data within the packet and the SCLK Mod 91 count. The MAG Synchronization Index is equal to the SCLK Mod 91 count.

A2.7.3 Instrument Status. The contents of the Instrument Status section are two bytes of subcommutated analog and digital status values. This is shown in Table A2.7.1. The positions are shown relative to synchronization index in Table A2.7.2.

Table A2.7.1 Instrument Status (MSB is bit 1)

Bit(s)	Measurement	Contents
1-8	Most significant 8 bits of subcommutated instrument status data.	8 MSB's of subcommutated data

```
|1|2|3|4|5|6|7|8|
```

MAG Byte #1

Bit(s)	Measurement	Contents
1-8	Least significant 8 bits of subcommutated instrument status data.	8 LSB's of subcommutated data

```
|1|2|3|4|5|6|7|8|
```

MAG Byte #2

TABLE A2.7.2 Instrument Status Subcommutated Data

SI	MEASUREMENT	CONTENTS
0	Current Scale Factor	0000000000000010= Inboard sensor high (±16 KnT) 0000000001000000= Inboard sensor low or Outboard sensor high (±512 nT) 0000100000000000=Outboard sensor low (±16 nT) ALL OTHERS ARE N/A
1	MAG select and gain select	0101XXXXXXXXXXXX(*)= Outboard sensor on 1010XXXXXXXXXXXX= Outboard sensor off XXXXXXXX0101XXXX= Inboard sensor on XXXXXXXX1010XXXX= Inboard sensor off XXXX0101XXXXXXXX= Outboard sensor gain high XXXX1010XXXXXXXX= Outboard sensor gain low XXXXXXXXXXXX0101= Inboard sensor gain high XXXXXXXXXXXX1010= Inboard sensor gain low ALL OTHERS ARE N/A
2	Current flip positions	11100001XXXXXXXX= Outboard sensor flipped right 00011110XXXXXXXX= Outboard sensor flipped left XXXXXXXX11100001= Inboard sensor flipped right XXXXXXXX00011110= Inboard sensor flipped left ALL OTHERS ARE N/A
3	Last flip command	11100001XXXXXXXX= Outboard sensor commanded right 00011110XXXXXXXX= Outboard sensor commanded left XXXXXXXX11100001= Inboard sensor commanded right XXXXXXXX00011110= Inboard sensor commanded left ALL OTHERS ARE N/A

(*) where X is irrelevent

TABLE A2.7.2 Instrument Status Subcommutated Data

SI	MEASUREMENT	CONTENTS
4	Calibrate enable/flip power enable	XXXXXXXX01010101= Calibrate power on XXXXXXXX10101010= Calibrate power off 00001000XXXXXXXX= Flipper power on (start, flipper power decrements from 1000 to 0000. A step occurs at every MOD 91 count) 00000000XXXXXXXX= Flipper power off ALL OTHERS ARE N/A
5	Gain 1	-2 to +1.999939
6	Gain 2	-2 to +1.999939
7	Gain 3	-2 to +1.999939
8	Offset 1	Field Units
9	Offset 2	Field Units
10	Offset 3	Field Units
11	Rotation 11	-1 to +0.9999695
12	Rotation 12	-1 to +0.9999695
13	Rotation 13	-1 to +0.9999695
14	Rotation 21	-1 to +0.9999695
15	Rotation 22	-1 to +0.9999695
16	Rotation 23	-1 to +0.9999695
17	Rotation 31	-1 to +0.9999695
18	Rotation 32	-1 to +0.9999695
19	Rotation 33	-1 to +0.9999695
20	Despin status	01010101XXXXXXXX= Despin on 10101010XXXXXXXX= Despin off ALL OTHERS ARE N/A
21	S/C time	16 MSB's of RIM
22	S/C time	8 LSB of RIM, and MOD 91 count
23	Spin angle	spin angle as received from CDS
24	Spin delta angle	spin delta as received from CDS
25	X_{DSPIN} at 21	Field Units
26	Y_{DSPIN} at 21	Field Units
27	Z_{DSPIN} at 21	Field Units
28	Calibration coil	01010101XXXXXXXX= on 10101010XXXXXXXX= off ALL OTHERS ARE N/A
29	Optimal averager/ snapshot data status	01010101XXXXXXXX= Optimal averager on 10101010XXXXXXXX= Optimal averager off XXXXXXXX01010101= Snapshot data on XXXXXXXX10101010= Snapshot data off ALL OTHERS ARE N/A
30	Memory keep alive volt	-20 V. to +19.9993900 V
31	+12 Volts DC	-20 V. to +19.9993900 V
32	+10 Volts DC	-20 V. to +19.9993900 V
33	-12 Volts DC	-20 V. to +19.9993900 V

TABLE A2.7.2 Instrument Status Subcommutated Data

SI	MEASUREMENT	CONTENTS
34	Reference V+	-20 V. to +19.9993900 V
35	Reference Gnd	-5 V. to +5 V.
36	Temperature Electronics	-5 V. to +4.9998475 V.
37	+V - clip	-5 V. to +4.9998475 V.
38	-V - clip	-5 V. to +4.9998475 V.
39	Parity error counters	MSByte=H/W, LSByte=S/W
40	XNF	Field Units
41	YNF	Field Units
42	ZNF	Field Units
43	spare	
44	spare	
45	spare	
46	DSP-Constant	
47	Aver #	
48	spare	
49	spare	
50	X_θ aver	Field Units
51	X_θ Sin θ aver	Field Units
52	X_θ Cos θ aver	Field Units
53	Y_θ aver	Field Units
54	Y_θ Sin θ aver	Field Units
55	Y_θ Cos θ aver	Field Units
56	Z_θ aver	Field Units
57	Z_θ Sin θ aver	Field Units
58	Z_θ Cos θ aver	Field Units
59	spare	
60	ROM checksum pointer	0 to 4000
61	ROM checksum	LSByte=0 to 255
62	RAM checksum pointer	16384 to 20480
63	RAM checksum	LSByte=0 to 255
64	ROM CKSUM (POR)	CKSUM $0000 - $0FFF
65	RAM CKSUM (POR)	CKSUM $4000 - $46FF
66	S/C time	16 MSB's of RIM
67	S/C time	8 LSB of RIM, and MOD 91 count
68	Spin angle	spin angle as received from CDS
69	Spin delta angle	spin delta as received from CDS
70	X_{DSPIN} aver at 66	Field Units
71	Y_{DSPIN} aver at 66	Field Units
72	Z_{DSPIN} aver at 66	Field Units
73	Data buffer beginning address	4800 (HEX) to 4D00 (HEX)
74	Data buffer	Field Units
75	Data buffer	Field Units
76	Data buffer	Field Units
77	Data buffer	Field Units
78	Data buffer	Field Units

TABLE A2.7.2 Instrument Status Subcommutated Data

SI	MEASUREMENT	CONTENTS
79	Data buffer	Field Units
80	Data buffer	Field Units
81	Data buffer	Field Units
82	Data buffer	Field Units
83	Data buffer	Field Units
84	Data buffer	Field Units
85	Data buffer	Field Units
86	Data buffer	Field Units
87	Data buffer	Field Units
88	Data buffer	Field Units
89	Data buffer	Field Units
90	Command counter	Set to zero at each POR

A.2.7.3.1 Data Buffer Format. The data provided in the OPTIMAL AVERAGING, and SNAPSHOT modes of the magnetometer is stored in a data buffer provided between locations 4800-4D00. This data includes the current storage pointer, start time, sector data and 200 vector samples of the magnetic field in the OPTIMAL AVERAGER MODE. In the SNAPSHOT mode, the data is stored in reverse order due to timing restrictions in the interrupt handling routines, and includes the start time and 210 vector samples. Format details are provided in Table A.2.7.3. This data is read out in 16 16-bit blocks once each MOD91 frame from address 4800-4D00 and placed in the magnetometer subcommutated data from SI=74 through SI=89. (see Table A.2.7.2). In order to collect one complete buffer of data, approximately 40 frames must be read. The data readout continuously cycles between addresses 4800-4D00.

TABLE A.2.7.3 MAG DATA BUFFER CONTENT

OPTIMAL AVERAGER		SNAPSHOT	
Memory Location		Memory Location	
4800	8 MSB of X @ T_o	4800	8 LSB Sensor 3 data @ T_{209}
4801	8 LSB of X @ T_o	4801	8 MSB Sensor 3 data @ T_{209}
4802	8 MSB of Y @ T_o	4802	8 LSB Sensor 2 data @ T_{209}
4803	8 LSB of Y @ T_o	4803	8 MSB Sensor 2 data @ T_{209}
4804	8 MSB of Z @ T_o	4804	8 LSB Sensor 1 data @ T_{209}
4805	8 LSB of Z @ T_o	4805	8 MSB Sensor 1 data @ T_{209}
.	.	.	.
.	.	.	.
.	.	.	.
4CAA	8 MSB of X @ T_{199}	4CE6	8 LSB Sensor 3 data @ T_o
4CAB	8 LSB of X @ T_{199}	4CE7	8 MSB Sensor 3 data @ T_o
4CAC	8 MSB of Y @ T_{199}	4CE8	8 LSB Sensor 2 data @ T_o
4CAD	8 LSB of Y @ T_{199}	4CE9	8 MSB Sensor 2 data @ T_o
4CAE	8 MSB of Z @ T_{199}	4CEA	8 LSB Sensor 1 data @ T_o
4CAF	8 LSB of Z @ T_{199}	4CEB	8 MSB Sensor 1 data @ T_o
4CC4	Current storage pointer	4CF1	16 MSB of RIM (SCLK)
4CF0	16 MSB of RIM (SCLK)	4CF3	8 LSB of RIM and MOD91
4CF2	8 MSB of RIM and MOD91		
4CF4	S/C Sector Data		

In the "Optimal Average" mode timing between vectors is controlled by the AVERAGE # found in SI47 of the instrument status data. The timing is always a multiple of the MOD91 timing and is defined by

$$\text{DELTA T} = (\text{AVERAGE \#} + 1) * 60.6666$$

In the "Snap Shot" mode timing between vectors is 33.3 ms or 30 vectors per second.

A2.7.4 1st Science Sample. The 1st Science Sample section contains 3 (16 bit) samples of sensor data collected exactly 1 MOD 91 count prior to the SCLK MOD 91 count of the LRS frame they are within. The 3 (16 bit) samples are 3 measurements corresponding to the X, Y, and Z axis, respectively. The measurements are output in field units, which can be converted to nano-teslas (nT) by dividing by the scale value provided in the instrument status (SI=0, Table A2.7.2).

$$\mathrm{Field}_{nT} = (\mathrm{Field}_{FU})/\mathrm{SCALE}\ (*)$$

(*) SCALE shall be commandable to a selected value.

Each sample is a 16 bit two's complement word which ranges from -32768 to +32767

A2.7.5 2nd Science Sample. The 2nd Science Sample section contains 3 (16 bit) samples of sensor data collected at 222.22 ms after the MOD 91 count prior to the SCLK MOD 91 count of the LRS frame they are within. The 3 (16 bit) samples are 3 measurements corresponding to the X, Y, and Z axis, respectively. The measurements are output in field units, which can be converted to nano-teslas (nT) by dividing by the scale value provided in the instrument status (SI=0, Table A2.7.2).

$$\mathrm{Field}_{nT} = (\mathrm{Field}_{FU})/\mathrm{SCALE}$$

Each sample is a 16 bit two's complement word which ranges from -32768 to +32767

A2.7.6 3rd Science Sample. The 3rd Science Sample section contains 3 (16 bit) samples of sensor data collected at 444.44 ms after the MOD 91 count prior to the SCLK MOD 91 count of the LRS frame they are within. The 3 (16 bit) samples are 3 measurements corresponding to the X, Y, and Z axis, respectively. The measurements are output in field units, which can be converted to nano-teslas (nT) by dividing by the scale value provided in the instrument status (SI=0, Table A2.7.2).

$$\mathrm{Field}_{nT} = (\mathrm{Field}_{FU})/\mathrm{SCALE}$$

Each sample is a 16 bit two's complement word which ranges from -32768 to +32767

A2.7.7 Telemetry Mode Changes. Upon the application of system power, MAG shall automatically configure itself to a standby mode. MAG data packets will contain no valid data in this mode.
Commanded telemetry mode changes are processed every RIM.

A2.8 NEAR INFRARED MAPPING SPECTROMETER SUBSYSTEM TELEMETRY

This paragraph describes the format and content of the NIMS output.

A2.8.1 NIMS Low Rate Science Packet. The schematic of the NIMS Low Rate Science packet is shown in Figure A2.8.1. One NIMS packet is placed in each LRS frame.

Title	Digital Status & Analog Engineering
Data offset	0
Bits/packet	24
Description	A2.8.1.2

Figure A2.8.1 NIMS LRS Packet

A2.8.1.1 Instrument Synchronicity. There will exist *one major* synchronism for the NIMS data output within the LRS frame. The Synchronization Index will be equal to the SCLK MOD 91 count.

A2.8.1.2 LRS Digital Status & Analog Engineering. The LRS Digital Status & Analog Engineering section is 3 bytes of subcommutated data. Table A2.8.1 gives the contents of each NIMS housekeeping word, and Table A2.8.2 gives the subcommutated positions of each of the housekeeping words. All subcommutated positions not explicitly called out and described are spares. As an example, Word #1 (mode repeat count) is described in Table A2.8.1. The position of the word in the NIMS LRS packet is (shown in Table A2.8.2) Byte 1, and occurs when the MOD 91 count is 0.

Table A2.8.1 LRS Digital Status & Analog Engineering (MSB is bit 1)

Bit(s)	Measurement	Contents
1-8	mode repeat count: PTAB 1	# of times to repeat this table before switching to PTAB 2

|1|2|3|4|5|6|7|8| NIMS Housekeeping Word 1

Bit(s)	Measurement	Contents
1	mirror operation bit: PTAB 1	1=mirror is scanning 0=mirror is fixed
2	autobias operation bit: PTAB 1	1=autobias off 0=autobias on
3-8	grating start position: PTAB 1	

|1|2|3|4|5|6|7|8| NIMS Housekeeping Word 2

Table A2.8.1 LRS Digital Status & Analog Engineering (MSB is bit 1)

Bit(s)	Measurement	Contents
1-8	grating delta: PTAB 1	# of steps grating will move after mirror scan

|1|2|3|4|5|6|7|8| NIMS Housekeeping Word 3

Bit(s)	Measurement	Contents
1-8	grating cycle steps: PTAB 1	total # of steps in grating cycle

|1|2|3|4|5|6|7|8| NIMS Housekeeping Word 4

Bit(s)	Measurement	Contents
1-8	mode repeat count: PTAB 2	# of times to repeat this table before switching to PTAB 1

|1|2|3|4|5|6|7|8| NIMS Housekeeping Word 5

Bit(s)	Measurement	Contents
1	mirror operation bit: PTAB 2	1=mirror is scanning 0=mirror is fixed
2	autobias operation bit: PTAB 2	1=autobias off 0=autobias on
3-8	grating start position: PTAB 2	

|1|2|3|4|5|6|7|8| NIMS Housekeeping Word 6

Bit(s)	Measurement	Contents
1-8	grating delta: PTAB 2	# of steps grating will move after mirror scan

|1|2|3|4|5|6|7|8| NIMS Housekeeping Word 7

Bit(s)	Measurement	Contents
1-8	grating cycle steps: PTAB 2	total # of steps in grating cycle

|1|2|3|4|5|6|7|8| NIMS Housekeeping Word 8

Bit(s)	Measurement	Contents
1-8	grating position	positions 0-25, 26-255 are N/A

|1|2|3|4|5|6|7|8| NIMS Housekeeping Word 9

Bit(s)	Measurement	Contents
1-8	7th byte cmd buffer	

|1|2|3|4|5|6|7|8| NIMS Housekeeping Word 10

Bit(s)	Measurement	Contents
1-8	6th byte cmd buffer	

|1|2|3|4|5|6|7|8| NIMS Housekeeping Word 11

Table A2.8.1 LRS Digital Status & Analog Engineering (MSB is bit 1)

Word	Bit(s)	Measurement	Contents
NIMS Housekeeping Word 12	1-8	5th byte cmd buffer	
NIMS Housekeeping Word 13	1-8	4th byte cmd buffer	
NIMS Housekeeping Word 14	1-8	3rd byte cmd buffer	
NIMS Housekeeping Word 15	1-8	2nd byte cmd buffer	
NIMS Housekeeping Word 16	1-8	LS byte cmd buffer	
NIMS Housekeeping Word 17	1-8	NIMS Xaction parity error	count of bus parity errors in transaction
NIMS Housekeeping Word 18	1-8	Bus parity error	count of all bus parity errors
NIMS Housekeeping Word 19	1-8	power supply input I	0 to 400 ma
NIMS Housekeeping Word 20	1-8	ave mirror drive I	0 to 200 ma
NIMS Housekeeping Word 21	1-8	ave grating drive I	0 to 200 ma

Table A2.8.1 LRS Digital Status & Analog Engineering (MSB is bit 1)

Bit(s)	Measurement	Contents
1-8	reference voltage	0 to 24 volts

|1|2|3|4|5|6|7|8| NIMS Housekeeping Word 22

Bit(s)	Measurement	Contents
1	h/w parity error in cmd or S/C time hdr	0=no error detected 1=error detected
2	memory location status	0=ROM 1=RAM
3-4	gain state	00=gain 2 01=gain 4 10=gain 3 11=gain 1
5	electronics calibrate	0=cal off 1=cal on
6	optics cal status	0=cal lamp off 1=cal lamp on
7-8	chopper status	00=chopper on, synchron. 01=chopper on, synchron. 10=chopper off 11=chopper on, free run

|1|2|3|4|5|6|7|8| NIMS Housekeeping Word 23

Bit(s)	Measurement	Contents
1	parity error in S/C time data	0=no error detected 1=error detected
2	parity error in command data	0=no error detected 1=error detected
3	chopper synchronization	0=chopper in sync with RTI 1=chopper not in sync with RTI
4	ADC/MUX error	0=operation normal 1=operation not completed in allotted time
5	formatter error	0=operation normal completed in allotted in allotted time
6	MOD 91 count error	0=no error detected 1=transmitted MOD 91 count does not equal the internal MOD 91 count
7	MOD 10 count error	0=no error detected 1=transmitted MOD 10 count does not equal the internal MOD 10 count
8	new command flag	0=no cmd received 1=new cmd received

|1|2|3|4|5|6|7|8| NIMS Housekeeping Word 24

Table A2.8.1 LRS Digital Status & Analog Engineering (MSB is bit 1)

Bit(s)	Measurement	Contents
1	current PTAB	0=PTAB 1 1=PTAB 2
2-8	spare	

|1|2|3|4|5|6|7|8| NIMS Housekeeping Word 25

Bit(s)	Measurement	Contents
1-8	optics cal source I	0 to 100 ma

|1|2|3|4|5|6|7|8| NIMS Housekeeping Word 26

Bit(s)	Measurement	Contents
1-6	spares	
7-8	Si channel MS byte	

|1|2|3|4|5|6|7|8| NIMS Housekeeping Word 27

Bit(s)	Measurement	Contents
1-8	Si channel LS byte	

|1|2|3|4|5|6|7|8| NIMS Housekeeping Word 28

Bit(s)	Measurement	Contents
1-6	spares	
7-8	InSb channel MS byte	

|1|2|3|4|5|6|7|8| NIMS Housekeeping Word 29

Bit(s)	Measurement	Contents
1-8	InSb channel LS byte	

|1|2|3|4|5|6|7|8| NIMS Housekeeping Word 30

Bit(s)	Measurement	Contents
1-8	check sum	ROM check sum

|1|2|3|4|5|6|7|8| NIMS Housekeeping Word 31

Table A2.8.2 NIMS LRS Housekeeping Word Subcommutated Positions

	Subcommutated	Positions
Word #	Byte	MOD 91
1	1	0
2	2	0
3	3	0
4	1	1
5	2	1
6	3	1
7	1	2
8	2	2
9	3	2, 5-90
10	1	3
11	2	3
12	3	3
13	1	4
14	2	4
15	3	4
16	1	5
17	2	5
18	2	6
19	1	7
20	2	7
21	1	8
22	2	8
23	1	10
24	2	10
25	2	11-65, 68-90
26	1	16
27	1	66
28	2	66
29	1	67
30	2	67
31	1	90

A2.8.2 NIMS High Rate Data Packet. The schematic of this packet is shown in Figure A2.8.2. At data rates of 28.8 kbps, 67.2 kbps, and 115.2 kbps, one NIMS high rate packet is placed in each frame of data (one frame every MOD 10 count). At data rates of 403.2 kbps and 806.4 kbps, one NIMS high rate packet is divided equally among 8 frames (one frame every MOD 8 count).

Title	Digital Status & Analog Engineering	Background	Sensor Data
Data offset	0	48	88
Bits/packet	48	40	680
Description	A2.8.2.2	A2.8.2.3	A2.8.2.4

Figure A2.8.2 NIMS High Rate Data Packet

A2.8.2.1 Instrument Synchronicity. The NIMS high rate data is synchronized only on a MOD 10 and MOD 91 basis.

A2.8.2.2 HRS Digital Status & Analog Engineering. The HRS Digital Status & Analog Engineering section consists of 6 bytes of subcommutated data. Table A2.8.3 gives the contents of each NIMS housekeeping word, and Table A2.8.4 gives the subcommutated positions of each of the housekeeping words. All subcommutated positions not explicitly called out and described are spares. As an example, Word #1 (mode repeat count) is described in Table A2.8.3. The position of the word in the NIMS High rate packet is (shown in Table A2.8.4) Byte 3, and occurs when the MOD 91 count is 0 through 90, and the MOD 10 count is 1, and again when the MOD 10 count is 6.

Table A2.8.3 HRS Digital Status & Analog Engineering (MSB is bit 1)

Bit(s)	Measurement	Contents
1-8	mode repeat count: current PTAB	# of times to repeat this table

|1|2|3|4|5|6|7|8| NIMS Housekeeping Word 1

Bit(s)	Measurement	Contents
1	mirror operation bit	1=mirror is scanning 0=mirror is fixed
2	autobias operation bit	1=autobias off 0=autobias on
3-8	grating start position	

|1|2|3|4|5|6|7|8| NIMS Housekeeping Word 2

Table A2.8.3 HRS Digital Status & Analog Engineering (MSB is bit 1)

Bit(s)	Measurement	Contents
1-8	grating delta	# of steps grating will move after mirror scan

|1|2|3|4|5|6|7|8| NIMS Housekeeping Word 3

Bit(s)	Measurement	Contents
1-8	grating cycle steps	total # of steps in grating cycle

|1|2|3|4|5|6|7|8| NIMS Housekeeping Word 4

Bit(s)	Measurement	Contents
1-8	grating position	positions 0-25, 26-255 are N/A

|1|2|3|4|5|6|7|8| NIMS Housekeeping Word 5

Bit(s)	Measurement	Contents
1-8	mirror position	positions 0-19, 20-255 are N/A

|1|2|3|4|5|6|7|8| NIMS Housekeeping Word 6

Bit(s)	Measurement	Contents
1-8	7th byte cmd buffer	

|1|2|3|4|5|6|7|8| NIMS Housekeeping Word 7

Bit(s)	Measurement	Contents
1-8	6th byte cmd buffer	

|1|2|3|4|5|6|7|8| NIMS Housekeeping Word 8

Bit(s)	Measurement	Contents
1-8	5th byte cmd buffer	

|1|2|3|4|5|6|7|8| NIMS Housekeeping Word 9

Bit(s)	Measurement	Contents
1-8	4th byte cmd buffer	

|1|2|3|4|5|6|7|8| NIMS Housekeeping Word 10

Bit(s)	Measurement	Contents
1-8	3rd byte cmd buffer	

|1|2|3|4|5|6|7|8| NIMS Housekeeping Word 11

Bit(s)	Measurement	Contents
1-8	2nd byte cmd buffer	

|1|2|3|4|5|6|7|8| NIMS Housekeeping Word 12

Table A2.8.3 HRS Digital Status & Analog Engineering (MSB is bit 1)

Bit(s)	Measurement	Contents
1-8	LS byte cmd buffer	

|1|2|3|4|5|6|7|8| NIMS Housekeeping Word 13

Bit(s)	Measurement	Contents
1	h/w parity error in cmd or S/C time hdr	0=no error detected 1=error detected
2	memory location status	0=ROM 1=RAM
3-4	gain state	00=gain 2 01=gain 4 10=gain 3 11=gain 1
5	electronics calibrate	0=cal off 1=cal on
6	optics cal status	0=cal lamp off 1=cal lamp on
7-8	chopper status	00=chopper on, synchron. 01=chopper on, synchron. 10=chopper off 11=chopper on, free run

|1|2|3|4|5|6|7|8| NIMS Housekeeping Word 14

Bit(s)	Measurement	Contents
1	parity error in S/C time data	0=no error detected 1=error detected
2	parity error in command data	0=no error detected 1=error detected
3	chopper synchronization	0=chopper in sync with RTI 1=chopper not in sync with RTI
4	ADC/MUX error	0=operation normal 1=operation not completed in allotted time
5	formatter error	0=operation normal 1=operation not completed in allotted time
6	MOD 91 count error	0=no error detected 1=transmitted MOD 91 count does not equal the internal MOD 91 count
7	MOD 10 count error	0=no error detected 1=transmitted MOD 10 count does not equal the internal MOD 10 count
8	new command flag	0=no cmd received 1=new cmd received

|1|2|3|4|5|6|7|8| NIMS Housekeeping Word 15

Table A2.8.3 HRS Digital Status & Analog Engineering (MSB is bit 1)

Bit(s)	Measurement	Contents
1-8	NIMS Xaction parity error	count of bus parity errors in transaction

|1|2|3|4|5|6|7|8| NIMS Housekeeping Word 16

Bit(s)	Measurement	Contents
1-8	Bus parity error	count of all bus parity errors

|1|2|3|4|5|6|7|8| NIMS Housekeeping Word 17

Bit(s)	Measurement	Contents
1-8	power supply input I	0 to 400 ma

|1|2|3|4|5|6|7|8| NIMS Housekeeping Word 18

Bit(s)	Measurement	Contents
1-8	ave grating drive I	0 to 200 ma

|1|2|3|4|5|6|7|8| NIMS Housekeeping Word 19

Bit(s)	Measurement	Contents
1-8	ave mirror drive I	0 to 200 ma

|1|2|3|4|5|6|7|8| NIMS Housekeeping Word 20

Bit(s)	Measurement	Contents
1-8	reference voltage	0 to 24 volts

|1|2|3|4|5|6|7|8| NIMS Housekeeping Word 21

Bit(s)	Measurement	Contents
1-8	optics cal source I	0 to 100 ma

|1|2|3|4|5|6|7|8| NIMS Housekeeping Word 22

Bit(s)	Measurement	Contents
1-8	check sum	ROM check sum

|1|2|3|4|5|6|7|8| NIMS Housekeeping Word 23

Table A2.8.4 NIMS Housekeeping Word Subcommutated Positions

		Subcommutated Positions	
Word #	Byte	MOD 91	MOD 10
1	3	0-90	1,6
2	4	0-90	1,6
3	5	0-90	1,6
4	6	0-90	1,6
5	1	0-90	1,6
6	2	0-90	1,6
7	1	0	8
8	2	0	8
9	3	0	8
10	4	0	8
11	5	0	8
12	6	0	8
13	6	0	9
14	5	1	8
15	6	1	8
16	6	2	8
17	6	4	8
18	6	8	8
19	5	16	8
20	6	16	8
21	6	32	8
22	6	48	8
23	6	64	8

A2.8.2.3 Background Data. The contents of the Background data section consist of 5 bytes of background infrared science data. These 5 bytes comprise 4 (10 bit) words, as shown in Table A2.8.5. The background data from the 17 NIMS detectors are commutated into the Background data section as shown in Table A2.8.6.

Table A2.8.5 NIMS Background Data (MSB is bit 1)

Bit(s)	Measurement	Contents
1-8	8 MSB of NIMS Background word A	8 MSB of 10

|1|2|3|4|5|6|7|8| NIMS Background Byte 1

Bit(s)	Measurement	Contents
1-2	2 LSB of NIMS Background word A	2 LSB of 10
3-8	6 MSB of NIMS Background word B	6 MSB of 10

|1|2|3|4|5|6|7|8| NIMS Background Byte 2

Table A2.8.5 NIMS Background Data (MSB is bit 1)

Bit(s)	Measurement	Contents
1-4	4 LSB of NIMS Back-ground word B	4 LSB of 10
5-8	4 MSB of NIMS Back-ground word C	4 MSB of 10

|1|2|3|4|5|6|7|8| NIMS Background Byte 3

Bit(s)	Measurement	Contents
1-6	6 LSB of NIMS Back-ground word C	6 LSB of 10
7-8	2 MSB of NIMS Back-ground word D	2 MSB of 10

|1|2|3|4|5|6|7|8| NIMS Background Byte 4

Bit(s)	Measurement	Contents
1-8	8 LSB of NIMS Back-ground word D	8 LSB of 10

|1|2|3|4|5|6|7|8| NIMS Background Byte 5

Table A2.8.6 NIMS Background Data Commutation

MOD 10 count	Word A	Word B	Word C	Word D
1, 6	detector 1	detector 2	detector 3	detector 4
2, 7	detector 5	detector 6	detector 7	detector 8
3, 8	detector 9	detector 10	detector 11	detector 12
4, 9	detector 13	detector 14	detector 15	detector 16
5, 0	detector 17	spare	spare	spare

A2.8.2.4 Sensor Data. The contents of the Sensor Data section is 85 bytes of infrared sensor data. Each block of 5 bytes contains 4 (10 bit) words of NIMS sensor data. This is shown in Table A2.8.7. Within each 5 MOD 10 counts, each of the 17 NIMS detectors are sampled 20 times. The commutation of this data into the packet is shown in Table A2.8.8. The chopper cycle of each sample is also given in Table A2.8.8, with N determined by Table A2.8.9.

Table A2.8.7 NIMS Sensor Data (MSB is bit 1)

Bit(s)	Measurement	Contents
1-8	8 MSB of NIMS Sensor word A	8 MSB of 10

|1|2|3|4|5|6|7|8| NIMS Sensor Bytes 1, 6, 11, ... 81

Bit(s)	Measurement	Contents
1-2	2 LSB of NIMS Sensor word A	2 LSB of 10
3-8	6 MSB of NIMS Sensor word B	6 MSB of 10

|1|2|3|4|5|6|7|8| NIMS Sensor Bytes 2, 7, 12, ... 82

Bit(s)	Measurement	Contents
1-4	4 LSB of NIMS Sensor word B	4 LSB of 10
5-8	4 MSB of NIMS Sensor word C	4 MSB of 10

|1|2|3|4|5|6|7|8| NIMS Sensor Bytes 3, 8, 13, ... 83

Bit(s)	Measurement	Contents
1-6	6 LSB of NIMS Sensor word C	6 LSB of 10
7-8	2 MSB of NIMS Sensor word D	2 MSB of 10

|1|2|3|4|5|6|7|8| NIMS Sensor Bytes 4, 9, 14, ... 84

Bit(s)	Measurement	Contents
1-8	8 LSB of NIMS Sensor word D	8 LSB of 10

|1|2|3|4|5|6|7|8| NIMS Sensor Bytes 5, 10, 15, ... 85

Table A2.8.8 NIMS Sensor Data Commutation

	Word A		Word B		Word C		Word D	
Bytes	chopper cycle	sensor number	chopper cycle	sensor number	chopper cycle	sensor number	chopper cycle	sensor number
1-5	N	1	N	2	N	3	N	4
6-10	N	5	N	6	N	7	N	8
11-15	N	9	N	10	N	11	N	12
16-20	N	13	N	14	N	15	N	16
21-25	N	17	N+1	1	N+1	2	N+1	3
26-30	N+1	4	N+1	5	N+1	6	N+1	7
31-35	N+1	8	N+1	9	N+1	10	N+1	11
36-40	N+1	12	N+1	13	N+1	14	N+1	15
41-45	N+1	16	N+1	17	N+2	1	N+2	2
46-50	N+2	3	N+2	4	N+2	5	N+2	6
51-55	N+2	7	N+2	8	N+2	9	N+2	10
56-60	N+2	11	N+2	12	N+2	13	N+2	14
61-65	N+2	15	N+2	16	N+2	17	N+3	1
66-70	N+3	2	N+3	3	N+3	4	N+3	5
71-75	N+3	6	N+3	7	N+3	8	N+3	9
76-80	N+3	10	N+3	11	N+3	12	N+3	13
81-85	N+3	14	N+3	15	N+3	16	N+3	17

Table A2.8.9 NIMS Chopper Cycle Commutation

MOD 10 count	N
1, 6	0
2, 7	4
3, 8	8
4, 9	12
5, 0	16

A2.8.3 Telemetry Mode Changes. Upon the application of system power, NIMS shall automatically configure itself to an instrument safe mode. The Digital Status and Analog Engineering data shall be valid.
Commanded telemetry mode changes are processed just prior to every RIM change. Telemetry mode changes shall occur at the RIM change after command processing.

A2.9 PLASMA SUBSYSTEM TELEMETRY

This paragraph describes the format and content of the PLS output.

A2.9.1 PLS Packet. The schematic of the packet is shown in Figure A2.9.1. One full PLS packet is distributed over 364 LRS frames.

```
 ------------------------------------------------
|      Spin number and subcommutated analog data   |
|--------------------------------------------------|
|           |                                      |
|  Digital  |         Floating Block Area          |
|   Status  |                                      |
|   Block   |                                      |
|-----------|--------------------------------------|
```

Figure A2.9.1 PLS Packet

A2.9.2 Instrument Synchronicity. Within the PLS packet, there will exist one major synchronism relative to the SCLK. The relationship between SCLK and PLS synchronization Index is shown in Table A2.9.1.

Table A2.9.1 SCLK vs. PLS S.I.

Rim (Modulo 4)	S.I.
0	Mod 91
1	91 + Mod 91
2	182 + Mod 91
3	273 + Mod 91

A2.9.3 PLS Fixed Telemetry. There are two areas of fixed telemetry in the PLS packet. The spin number and subcommutated Analog data are placed in the first two bytes of each PLS portion of an LRS frame. The Digital Status Block is located at the start of the PLS packet (S.I. equals 0).

A2.9.3.1 Spin Number and Subcommutated Analog Data. Bytes 1 and 2 of each PLS portion of an LRS frame contain the spin number pertaining to that frame, and subcommutated Analog data, respectively. The contents of the spin number byte are shown in Table A2.9.2.

Table A2.9.2 Spin Number

Bits	Measurement	Content
1-4	spin mode number for instrument A	0<N<15
5-8	spin mode number for instrument B	0<N<15

```
 ------------- 
      |        ----- 
      |
    --|--   --|--
    |   | |   |
   |1|2|3|4|5|6|7|8|
```

The subcommutated Analog Housekeeping is the second byte in all PLS portions of the LRS frame, and contains the data shown in Table A2.9.3. The relationship of these words to S.I. is also shown in Table A2.9.3.

Table A2.9.3. PLS Subcommutated Analog Housekeeping

Bits	Measurement	Content
1-8	detector bias monitor A	0 to 3800 volts

```
|1|2|3|4|5|6|7|8|
```

Byte 1, S.I. = 0, 1, 92, 183, 274

Bits	Measurement	Content
1-8	LVPS +27.0V A; plate/bias	0 to 40 volts

```
|1|2|3|4|5|6|7|8|
```

Byte 2, S.I. = 2, 93, 184, 275

Bits	Measurement	Content
1-8	LVPS +27.0V A; pull-down	0 to 40 volts

```
|1|2|3|4|5|6|7|8|
```

Byte 3, S.I. = 3, 94, 185, 276

Bits	Measurement	Content
1-8	LVPS +25.0V A	0 to 40 volts

```
|1|2|3|4|5|6|7|8|
```

Byte 4, S.I. = 4, 95, 186, 277

Bits	Measurement	Content
1-8	supplemental heater monitor	-35 to +50 deg. C

```
|1|2|3|4|5|6|7|8|
```

Byte 5, S.I. = 5, 96, 187, 278

Bits	Measurement	Content
1-8	LVPS +10.0V A	0 to 15 volts

```
|1|2|3|4|5|6|7|8|
```

Byte 6, S.I. = 6, 97, 188, 279

Bits	Measurement	Content
1-8	LVPS +7.5V A	0 to 10 volts

```
|1|2|3|4|5|6|7|8|
```

Byte 7, S.I. = 7, 98, 189, 280

Bits	Measurement	Content
1-8	LVPS +6.0V A	0 to 10 volts

```
|1|2|3|4|5|6|7|8|
```

Byte 8, S.I. = 8, 99, 190, 281

Table A2.9.3. PLS Subcommutated Analog Housekeeping

Byte	Bits	Measurement	Content
|1|2|3|4|5|6|7|8| Byte 9, S.I. = 9, 100, 191, 282	1-8	LVPS +5.0V A	0 to 10 volts
|1|2|3|4|5|6|7|8| Byte 10, S.I. = 10, 101, 192, 283	1-8	LVPS -8.0V A	0 to -10 volts
|1|2|3|4|5|6|7|8| Byte 11, S.I. = 11, 102, 193, 284	1-8	temperature regulator	-35 to 50 deg. C
|1|2|3|4|5|6|7|8| Byte 12, S.I. = 12, 103, 194, 285	1-8	7.8V T monitor (open) temperature; m.s. 2 housing (closed)	0 to 127=cover open, voltage monitor 128 to 255=cover closed, temperature -35 to 50 deg. C
|1|2|3|4|5|6|7|8| Byte 13, S.I. = 13, 104, 195, 286	1-8	7.8V T monitor (closed) temperature; m.s. 2 housing (open)	0 to 127=cover closed, voltage monitor 128 to 255=cover open, temperature -35 to 50 deg. C
|1|2|3|4|5|6|7|8| Byte 14, S.I. = 14, 105, 196, 287	1-8	analog ground reference A	0.0 volts
|1|2|3|4|5|6|7|8| Byte 15, S.I. = 15, 106, 197, 288	1-8	detector bias monitor B	0 to 3800 volts
|1|2|3|4|5|6|7|8| Byte 16, S.I. = 16, 107, 198, 289	1-8	LVPS +27.0V B; plate/bias	0 to 40 volts

Table A2.9.3. PLS Subcommutated Analog Housekeeping

Byte	Bits	Measurement	Content
Byte 17, S.I. = 17, 108, 199, 290	1-8	LVPS +27.0V B; pull-down	0 to 40 volts
Byte 18, S.I. = 18, 109, 200, 291	1-8	LVPS +25.0V B; m.s. 1	0 to 40 volts
Byte 19, S.I. = 19, 110, 201, 292	1-8	LVPS +25.0V B; m.s. 3	0 to 40 volts
Byte 20, S.I. = 20, 111, 202, 293	1-8	LVPS +10.0V B	0 to 15 volts
Byte 21, S.I. = 21, 112, 203, 294	1-8	LVPS +7.5V B	0 to 10 volts
Byte 22, S.I. = 22, 113, 204, 295	1-8	LVPS +6.0V B	0 to 10 volts
Byte 23, S.I. = 23, 114, 205, 296	1-8	LVPS +5.0V B	0 to 10 volts
Byte 24, S.I. = 24, 115, 206, 297	1-8	LVPS -8.0V B	0 to -10 volts
Byte 25, S.I. = 25, 116, 207, 298	1-8	temperature; m.s. Q	-35 to 50 deg. C

Table A2.9.3. PLS Subcommutated Analog Housekeeping

Bits	Measurement	Content	Byte
1-8	temperature; bias A	-35 to 50 deg. C	Byte 26, S.I. = 26, 117, 208, 299
1-8	Analog ground reference B	0.0 volts	Byte 27, S.I. = 27, 118, 209, 300
1-8	energy analyzer A HV monitor steps 0 to 63	0 to 2600 volts	Byte 28 to 91, S.I. = 28 - 91
1-8	energy analyzer B HV monitor steps 0 to 63	0 to 2600 volts	Byte 92 to 155, S.I. = 119 - 182
1-8	composition analyzer current monitor A steps 0 to 63	0 to 300 ma	Byte 156 to 219, S.I. = 210 - 273
1-8	composition analyzer current monitor B steps 0 to 63	0 to 300 ma	Byte 220 to 283, S.I. = 301 - 364

A2.9.3.2 Digital Status Block. The Digital Status Block is located at the start of the PLS packet (S.I. equals 0). The contents of this block are shown in Figure A2.9.2., and the bit definitions of the digital status bytes are shown in Table A2.9.4.

Byte 1	Block I. D. (06)
Byte 2	Block Size (47)
Byte 3	Enable Byte
Byte 4	Configuration Control Byte
Byte 5	Power Switching Byte
Byte 6	AACS S/C Clock Sectoring Byte
/ \ /	/ \ /
Byte 49	Last Critical Telemetry Byte

Figure A2.9.2. Digital Status Block

Table A2.9.4. Digital Status Data

Bit	Description	Value
1	spare	
2	composition analyzer step generator B (m.s. 3)	0=off 1=on
3	composition analyzer step generator B (m.s. 1)	0=off 1=on
4	detector bias step generator B	0=off 1=on
5	energy analyzer step generator B	0=off 1=on
6	energy analyzer step generator B	0=off 1=on
7	energy analyzer step generator B	0=off 1=on
8	energy analyzer step generator B	0=off 1=on

|1|2|3|4|5|6|7|8| Byte 3, Enable

Bit	Description	Value
1-2	spare	
3	instrument bus B enable	0=off 1=on
4	instrument bus A enable	0=off 1=on
5	bus adaptor beta enable	0=off 1=on
6	bus adaptor alpha enable	0=off 1=on
7	processor 2 enable	0=off 1=on
8	processor 1 enable	0=off 1=on

|1|2|3|4|5|6|7|8| Byte 4, Configuration Control

Table A2.9.4. Digital Status Data

1	auxiliary heater control B	0=off 1=on
2	auxiliary heater control A	0=off 1=on
3	supplemental heater control B	0=off 1=on
4	supplemental heater control A	0=off 1=on
5	low voltage -8.0 volts	0=off 1=on
6	low voltage +6.0 volts	0=off 1=on
7	low voltage +7.5 volts	0=off 1=on
8	low voltage +27 volts	0=off 1=on

|1|2|3|4|5|6|7|8| Byte 5, Power Switching

1-6	spare	
7-8	AACS-S/C Clock Sectoring	00=sectoring synchronized to S/C clock 01=AACS off-free running from last update 11=N/A

|1|2|3|4|5|6|7|8| Byte 6, AACS-S/C Clock Sectoring

1-8	MS byte of memory dump address	

|1|2|3|4|5|6|7|8| Byte 7, MS Byte of Memory Dump

1-8	LS byte of memory dump address	

|1|2|3|4|5|6|7|8| Byte 8, LS Byte of Memory Dump

1-8	peak detector sensor	I.D. (see Table A2.9.8) of detector sensor having the greatest modulation during previous spin

|1|2|3|4|5|6|7|8| Byte 8, MS Byte of Memory Dump

Table A2.9.4. Digital Status Data

Bits	Measurement	Content
1-8	peak sector	no. of sector in which peak is detected

|1|2|3|4|5|6|7|8| Byte 10, Peak Sector

Bits	Measurement	Content
1-8	peak energy	energy step in which peak is detected

|1|2|3|4|5|6|7|8| Byte 11, Peak Energy

Bits	Measurement	Content
1-8	peak mass	mass step in which peak is detected

|1|2|3|4|5|6|7|8| Byte 12, Peak Mass

Bits	Measurement	Content
1-8	commands accepted counter	count of commands accepted by bus adapter

|1|2|3|4|5|6|7|8| Byte 13, Commands Accepted Counter

Bits	Measurement	Content
1	spare	
2-3	redundant high voltage A control bits	00=high voltage off 01=high voltage on 10=high voltage on 11=high voltage on
4-8	high voltage A step number	step number 0-31

|1|2|3|4|5|6|7|8| Byte 14, CCM Bias Setting A

Bits	Measurement	Content
1	spare	
2-3	redundant high voltage B control bits	00=high voltage off 01=high voltage on 10=high voltage on 11=high voltage on
4-8	high voltage B step number	step number 0-31

|1|2|3|4|5|6|7|8| Byte 15, CCM Bias Setting B

Bits	Measurement	Content
1-8	command code causing error condition	

|1|2|3|4|5|6|7|8| Byte 16, Invalid Command Fault Code 1

Bits	Measurement	Content
1-8	SCLK MOD 91 count at time of command error	

|1|2|3|4|5|6|7|8| Byte 17, Invalid Command Fault Code 2

Table A2.9.4. Digital Status Data

Bits	Measurement	Content
1-4	LSB's of SCLK Real-time image count at time of command error	
5-8	SCLK MOD 10 count at time of command error	

Byte 18, Invalid Command Fault Code 3

Bits	Measurement	Content
1-8	invalid command count during PLS instrument cycle	

Byte 19, Invalid Command Fault Code 4

Bits	Measurement	Content
1-8	SCLK MOD 91 count at time of heater fault	

Byte 20, Supplemental Heater Monitor Fault Code 1

Bits	Measurement	Content
1-4	LSB's of SCLK Real-time image count at time of heater fault	
5-8	SCLK MOD 10 count at time of heater fault	

Byte 21, Supplemental Heater Monitor Fault Code 2

Bits	Measurement	Content
1-8	heater fault count during PLS instrument cycle	

Byte 22, Supplemental Heater Monitor Fault Code 3

Bits	Measurement	Content
1-4	spare	
5	ROM address 0C00 to 0FFF (HEX)	0=no error detected 1=error detected
6	ROM address 0800 to 0BFF (HEX)	0=no error detected 1=error detected
7	ROM address 0400 to 07FF (HEX)	0=no error detected 1=error detected
8	ROM address 0000 to 03FF (HEX)	0=no error detected 1=error detected

Byte 23, Memory Fault Code 1

Table A2.9.4. Digital Status Data

Byte 24, Memory Fault Code 2

Bits	Measurement	Content
1	RAM address 1700 to 17FF (HEX)	0=no error detected 1=error detected
2	RAM address 1600 to 16FF (HEX)	0=no error detected 1=error detected
3	RAM address 1500 to 15FF (HEX)	0=no error detected 1=error detected
4	RAM address 1400 to 14FF (HEX)	0=no error detected 1=error detected
5	RAM address 1300 to 13FF (HEX)	0=no error detected 1=error detected
6	RAM address 1200 to 12FF (HEX)	0=no error detected 1=error detected
7	RAM address 1100 to 11FF (HEX)	0=no error detected 1=error detected
8	RAM address 1000 to 10FF (HEX)	0=no error detected 1=error detected

|1|2|3|4|5|6|7|8| Byte 24, Memory Fault Code 2

Byte 25, Memory Fault Code 3

Bits	Measurement	Content
1	RAM address 1F00 to 1FFF (HEX)	0=no error detected 1=error detected
2	RAM address 1E00 to 1EFF (HEX)	0=no error detected 1=error detected
3	RAM address 1D00 to 1DFF (HEX)	0=no error detected 1=error detected
4	RAM address 1C00 to 1CFF (HEX)	0=no error detected 1=error detected
5	RAM address 1B00 to 1BFF (HEX)	0=no error detected 1=error detected
6	RAM address 1A00 to 1AFF (HEX)	0=no error detected 1=error detected
7	RAM address 1900 to 19FF (HEX)	0=no error detected 1=error detected
8	RAM address 1800 to 18FF (HEX)	0=no error detected 1=error detected

|1|2|3|4|5|6|7|8| Byte 25, Memory Fault Code 3

Bits	Measurement	Content
1-8	spare	

|1|2|3|4|5|6|7|8| Byte 26-38, spares

Bits	Measurement	Content
1-8	CDS bus parity error count (H/W)	

|1|2|3|4|5|6|7|8| Byte 39, CDS Bus Parity Error

Table A2.9.4. Digital Status Data

Byte 40, PLS Bus Parity Error

Bits	Mesurement	Content
1-8	PLS bus parity error count (S/W)	

Byte 41, A Accumulator Overflow Error

Bits	Mesurement	Content
1-8	A accumulator overflow error count	

Byte 42, A Accumulator Overflow Spinmode

Bits	Mesurement	Content
1-8	A accumulator overflow spinmode sequence number	

Byte 43, B Accumulator Overflow Error

Bits	Mesurement	Content
1-8	B accumulator overflow error count	

Byte 44, B Accumulator Overflow Spinmode

Bits	Mesurement	Content
1-8	B accumulator overflow spinmode sequence number	

Byte 45-49, Critical Telemetry Buffer

Bits	Mesurement	Content
1-8	critical telemetry buffer	TBD

A2.9.4 Floating Block Area. The Floating Block area is divided into 12 spin areas. The boundaries between spin areas are not fixed, but vary based on the size and number of blocks contained.

All blocks start with a one byte block ID code which specifies the type of block. All blocks then contain a one byte block length (except for sensor data blocks, para. A2.9.4.6.), followed by block entries. Some blocks always end with a one byte end code (FF_{hex}).

If a given block of this type cannot be completed within a given LRS frame, floating blocks in subsequent LRS frames will have the same block I.D. code and the block will continue until a block with that code terminates in (FF_{hex}).

The first spin area, in all PLS packets, will contain all blocks required to identify and process the science data contained in spin area 1. Subsequently , only changes or additions to the blocks will be contained within the spin area.

Blocks which can appear in the spin areas are shown in Table A2.9.5, in the order in which they occur. Not all blocks must appear in each spin. Additional blocks, which can occur anywhere in the floating block area, are shown in Table A2.9.6.

Table A2.9.5. Ordered Blocks

Block ID code		Length (bytes)	Para.
30	Mode Sequencing Block A	13	A2.9.4.1
32	Mode Sequencing Block B	13	A2.9.4.1
20	Sensor Sequencing Block A	N* (11 max.)	A2.9.4.2
22	Sensor Sequencing Block B	N (11 max.)	A2.9.4.2
28	Sector Sequencing Block A	6	A2.9.4.3
2A	Sector Sequencing Block B	6	A2.9.4.3
24	High Voltage Sequencing Block A	4	A2.9.4.4
26	High Voltage Sequencing Block B	4	A2.9.4.4
2C	Mass Analyzer Sequencing Block A	N (65 max.)	A2.9.4.5
2E	Mass Analyzer Sequencing Block B	N (65 max.)	A2.9.4.5
40+block count	Sensor Data A	N (1280 max)	A2.9.4.6
40+block count	Sensor Data B	N (1280 max)	A2.9.4.6

* size varies

Table A2.9.6. Non-ordered Blocks

Block ID code		Length (bytes)	Para.
00	NOP (fill)	N (47 max.)	A2.9.4.7
04	Analog Housekeeping	N (47 max.)	A2.9.4.10
06	Digital Status*	47	A2.9.3.2
08	Analog Sequencing Block	N (47 max.)	A2.9.4.9

* Occurs at start of every PLS packet.

A2.9.4.1 Mode Sequencing Block. The Mode Sequencing Block consists of 15 bytes of data, 12 of which determine the mode which the instrument is in for the 12 respective spins, The constents are shown in Figure A2.9.3, with the modes shown in Table A2.9.7.

Byte 1	Block I. D.
Byte 2	Block Size (13)
Byte 3	Mode number of spin 1 (see Table A2.9.9 for mode types
Byte 4	Mode number of spin 2 (see Table A2.9.9 for mode types
Byte 5	Mode number of spin 3 (see Table A2.9.9 for mode types
Byte 6	Mode number of spin 4 (see Table A2.9.9 for mode types
Byte 7	Mode number of spin 5 (see Table A2.9.9 for mode types
Byte 8	Mode number of spin 6 (see Table A2.9.9 for mode types
Byte 9	Mode number of spin 7 (see Table A2.9.9 for mode types
Byte 10	Mode number of spin 8 (see Table A2.9.9 for mode types
Byte 11	Mode number of spin 9 (see Table A2.9.9 for mode types
Byte 12	Mode number of spin 10 (see Table A2.9.9 for mode types
Byte 13	Mode number of spin 11 (see Table A2.9.9 for mode types
Byte 14	Mode number of spin 12 (see Table A2.9.9 for mode types
Byte 15	End Code (FF HEX)

Figure A2.9.3. Mode Sequencing Blocks

Table A2.9.7. PLS Modes

Mode Number	PLS Instrument A Mode	PLS Instrument B Mode
1	Velocity Distribution Survey	Velocity Distribution Survey
2	Beam Velocity Distribution	Beam Velocity Distribution
3	Mass Composition Survey (Detectors 2MI, 2MD)	Mass Composition Survey (Detectors 1MI, 1MD)
4	N/A	Mass Composition Survey (Detectors 3MI, 3MD)
5	Beam Mass Composition	Beam Mass Composition

A2.9.4.2 Sensor Sequencing Block. The Sensor Sequencing Block consists of an arbitrary number of detector I. D. words, terminated by a byte containing an End Code (FF_{HEX}).

Figure A2.9.4. depicts the contents of this block, and Table A2.9.8. shows the sensor I. D.'s.

Byte 1	Block I. D. (20=A, 22=B, HEX)
Byte 2	Block Size (N)
Byte 3	First sensor I. D.
Byte 4	Second sensor I. D.
Byte 5	Third sensor I. D.
Byte 6	Fourth sensor I. D.
/	/ /
\	\ \
/	/ /
Byte N+1	Last sensor I. D.
Byte N+2	End Code (FF HEX)

Figure A2.9.4. PLS Sensor Sequencing Block

Table A2.9.8. PLS Sensor I. D. Codes

I. D. Code	Sensor
02	2MI
06	1P
0A	3P
0E	5P
12	7P
42	2MD
46	1E
4A	3E
4E	5E
52	7E
82	1MI
86	3MI
8A	2P
8E	4P
92	6P
C2	1MD
C6	3MD
CA	2E
CE	4E
D2	6E

A2.9.4.3 <u>Sector Sequencing Block</u>. The Sector Sequencing Block consists of 8 bytes of data. Five of those determine the sector sequencing for the spin it is in, and subsequent spins until it is updated, or a new PLS packet starts. The contents of this block are shown in Figure A2.9.5.

Byte	Contents
Byte 1	Block I.D. (28=A, 2A=B, HEX)
Byte 2	Block Size (6)
Byte 3	AACS Clock angle of start of first sector (0 to 360 degrees, see A2.4, AACS Position and Rate Date)
Byte 4	Duration of each energy (or mass) step, in 8.33 ms units
Byte 5	Number of steps to be scanned in this sector
Byte 6	Clock angle increment to start of next sector
Byte 7	Number of sectors to be sampled in one spin
Byte 8	End Code (FF HEX)

Figure A2.9.5. Sector Sequencing Blocks

A2.9.4.4 High Voltage Sequencing Block. The High Voltage Sequencing Block contains 6 bytes, 3 of which determine the high voltage sequence gone through. The contents of this block are shown in Figure A2.9.6.

Byte	Contents
Byte 1	Block I.D. (24=A, 26=B, HEX)
Byte 2	Block Size (4)
Byte 3	Initial Step Number
Byte 4	Step Number Increment
Byte 5	Final Step Number
Byte 6	End Code (FF HEX)

Figure A2.9.6 High Voltage Sequencing Blocks

A2.9.4.5 Mass Analyzer Sequencing Block. The Mass Analyzer Sequencing Block contains lists of mass analyzer step numbers. The list is terminated by an entry of FF_{hex}.

This block is shown in Figure A2.9.7. The bit definitions of the step number bytes is shown in Table A2.9.9.

Byte	Contents
Byte 1	Block I.D. (2C=A, 2E=B, HEX)
Byte 2	Block Size (N)
Byte 3	First mass analysis step number
Byte 4	Second mass analysis step number
Byte 5	Third mass analysis step number
Byte 6	Fourth mass analysis step number
/	/ /
\	\ \
/	/ /
Byte N+1	Last mass analysis step number
Byte N+2	End Code (FF HEX)

Figure A2.9.7. Mass Analyzer Sequencing Blocks

Table A2.9.9. Mass Analysis step number bit definitions

1-2	spare	
3-8	mass analysis step numbers	0-63

|1|2|3|4|5|6|7|8| PLS Instrument A

1	spare	
2	mass spectrometer numbers	0=mass spectrometer 1 1=mass spectrometer 3
3-8	mass analysis step numbers	0 to 63

|1|2|3|4|5|6|7|8| PLS Instrument A

A2.9.4.6 Sensor Data Block. The Sensor Data Block contains sensor data, arranged in a sequence determined by the previously mentioned Sequencing Blocks. The sequence begins with the first sensor listed in the latest avaliable Sensor Sequencing Block, at the first entry in the latest Mass Analyzer Sequencing block, at the first entry in the latest High Voltage Sequencing block, and at the first entry in the latest Sector Sequencing block. After going through all entries in the Sensor Sequencing Block, it goes to the next entry in the Mass Analyzer Sequencing Block, then goes through the Sensor Sequencing Block again. This process is illustrated in Figure A2.9.8. This block is shown in Figure A2.9.9 The sensor data itself is logarithmically compressed. The decompression algorithm is given in Figure A2.9.10.

```
Sector Sequencing Block entry <-----------------------------------
                                                                  |
   High Voltage Sequencing Block entry <--------------------------   |
                                                               |  |
      Mass Analyzer Sequencing Block entry <-------------------  |  |
                                                            |  |  |
         Sensor Sequencing Block entry <-------------------   |  |  |
                                                         |  |  |  |
         Next Sensor Sequencing Block entry, till through -  |  |  |
                                                            |  |  |
      Next Mass Analyzer Sequencing Block entry, till through -  |  |
                                                               |  |
   Next High Voltage Sequencing Block entry, till through --------   |
                                                                  |
Next Sector Sequencing Block entry, till through ------------------
```

Figure A2.9.8. Sequencing of Sensor Data Block Entries.

Byte 1	Block I. D. (40 + N=A, 80 + N=B; where N=Block Size)
Byte 2	First sensor datum
Byte 3	Second sensor datum
Byte 4	Third sensor datum
Byte 5	Fourth sensor datum
/ \ /	/ \ /
Byte N	Last sensor datum

Figure A2.9.9. Sensor Data Blocks

Decompression

```
      X            C                             N
|1         4|5          8|  ----------->  |1                          16|
     PLS Data Word                          PLS Accumulator Value
```

Algorithm: for X=0 N=C

for X>0 $N=(16+C)\cdot 2^{(X-1)}$

Figure A2.9.10. Sensor Data Decompression Algorithm

A2.9.4.7 NOP (Fill) Block. The NOP block contains fill data used to fill the PLS telemetry allocation when no useful data is availiable. The contents of this block is shown in Figure A2.9.11.

Byte 1	Block I. D. (00)
Byte 2	Block Size (N)
Byte 3	Fill Data (00)
Byte 4	Fill Data (00)
/ \ /	/ \ /
Byte N+1	Fill Data (00)
Byte N+2	Fill Data (00)

Figure A2.9.11. NOP Block

A2.9.4.8 Deleted.

Figure A2.9.12. Deleted

A2.9.4.9 Analog Sequencing Block. This block specifies the contents of the Analog Housekeeping Block. The contents are shown in Figure A2.9.13. The measurements corresponding to the allowable values are shown in Table A2.9.10.

Byte 1	Block I. D. (08)
Byte 2	Block Size (N)
Byte 3	First Analog Measurement I.D.
Byte 4	Second Analog Measurement I.D.
Byte 5	Third Analog Measurement I.D.
/	/ /
\	\ \
/	/ /
Byte N+1	Last Analog Measurement I.D.
Byte N+2	End Code (FF HEX)

Figure A2.9.13. Analog Sequencing Block

Table A2.9.10. PLS Analog Measurement I. D. Codes

I.D. Code	Instrument	Measurement	Contents
00	A	energy analyzer high voltage	0 to 2600 volts
01	A	detector bias high voltage	0 to 3800 volts
02	A	composition analyzer current	0 to 150 ma
03	A	LVPS current	0 to 200 ma
04	A	energy analyzer current	0 to 20 ma
05	A	LVPS -8.0 volts	0 to -10 volts
06	A	LVPS +5 volts	0 to 8 volts
07	A	LVPS +6.5 volts	0 to 8 volts
08	A	LVPS +7.5 volts	0 to 10 volts
09	A	LVPS +10 volts	0 to 15 volts
0A	A	LVPS +27 volts	0 to 40 volts
0B	A	0 volts ref./ cover deploy	0 to 5 volts 0 volts=deployed 3 volts=closed
0C	A	temperature transducer	-78 to 100 degrees
0D	A	detector bias current	0 to 30 ma
0E	A	supplemental heater control	0 to 5 volts
0F	A	spare	
10	B	energy analyzer high voltage	0 to 2600 volts
11	B	detector bias high voltage	0 to 3800 volts

Table A2.9.10. PLS Analog Measurement I. D. Codes

I.D. Code	Instrument	Measurement	Contents
12	B	composition analyzer current	0 to 150 ma
13	B	LVPS current	0 to 200 ma
14	B	energy analyzer current	0 to 20 ma
15	B	LVPS -8.0 volts	0 to -10 volts
16	B	LVPS +5 volts	0 to 8 volts
17	B	LVPS +6.5 volts	0 to 8 volts
18	B	LVPS +7.5 volts	0 to 10 volts
19	B	LVPS +10 volts	0 to 15 volts
1A	B	LVPS +27 volts	0 to 40 volts
1B	B	0 volts ref./ cover deploy	0 to 5 volts 0 volts=deployed 3 volts=closed
1C	B	temperature transducer	-78 to 100 degrees
1D	B	detector bias current	0 to 30 ma
1E	B	spare	
1F	B	spare	

A2.9.4.10 Analog Housekeeping Block. This block is in addition to the fixed Subcommutated Analog Housekeeping. This block contains analog data whose contents are specified by the Analog Sequencing Block, para. A2.9.4.3. The contents are shown in Figure A2.9.14

Byte 1	Block I. D. (04)
Byte 2	Block Size (N)
Byte 3	First Analog Measurement Value
Byte 4	Second Analog Measurement Value
Byte 5	Third Analog Measurement Value
Byte 6	Fourth Analog Measurement Value
/ \ /	/ \ / / \ /
Byte N+1	Last Analog Measurement Value
Byte N+2	End Code (FF HEX)

Figure A2.9.14. Analog Housekeeping Block

A2.9.4.11 Deleted.

Figure A2.9.15. Deleted

A2.9.4.12 Deleted.

Figure A2.9.16. Deleted

A2.9.5 <u>Telemetry Mode Changes.</u> Upon the application of system power, PLS shall disable its high voltage, and configure itself to the instrument synchronicity shown in Table A2.9.1, and at the beginning of the next cycle, generate valid telemetry. Commanded telemetry mode changes shall be processed at the time of receipt. Telemetry mode changes shall occur at the beginning of the instrument cycle.

A2.10 PHOTOPOLARIMETER RADIOMETER SUBSYSTEM TELEMETRY

These paragraphs describe the format and content of the PPR output.

A2.10.1 PPR Packet. The schematic of this packet is shown in Figure A2.10.1. One PPR packet is placed in each LRS frame.

Title	Instrument Status	Status & Science	PPR Sci. Data 1	PPR Sci. Data 2	PPR Sci. Data 3
Data Offset	0	48	56	80	112
Bits/packet	48	8	24	32	32
Description	A2.10.3	A2.10.4	A2.10.5	A2.10.6	A2.10.7

Figure A2.10.1 PPR Packet

A2.10.2 Instrument Synchronicity. The contents of the PPR packet are uniquely determined by data available within the packet.

A2.10.3 Instrument Status. The contents of the digital status section are shown in Table A2.10.1.

Table A2.10.1 PPR Instrument Status (MSB is bit 1)

Bit(s)	Measurement	Contents
1	memory ID	0=memory #1 1=memory #2
2	command parity	0=no parity error 1=parity error
3	telemetry/sector parity	0=no parity error 1=parity error
4-5	valid command count (MOD 4)	00=command #0 01=command #1 10=command #2 11=command #3
6-8	mode	000=transition 001=cycle 1 010=PP/Ph 011=Ph 100=Rad 101=Position Select 110=Cycle 6 111=Cycle 7

|1|2|3|4|5|6|7|8| PPR Byte #1

Table A2.10.1 PPR Instrument Status (MSB is bit 1)

Bit(s)	Measurement	Contents
1-4	Gain PP/Ph	Gain Step 0-15
5-6	Gain Rad	Gain Step 0-3
7-8	Number of samples	00=1 sample 01=4 samples 10=16 samples 11=256 samples

|1|2|3|4|5|6|7|8| PPR Byte #2

Bit(s)	Measurement	Contents
1	number of samples multiplier	0=x1 1=x4
2-3	number of positions	00=0 00=1 10=2 11=5
4	calibration lamp	0=off 1=on
5	DCR initiate	0=inhibit 1=enable
6	boom sequence operation	0=inhibit 1=enable
7	chopper heater	0 (inoperative)
8	telemetry sent	0=current memory not read out 1=current memory read out

|1|2|3|4|5|6|7|8| PPR Byte #3

Bit(s)	Measurement	Contents
1-5	programmed Filter/ Retarder position	position 0-31
6	temperature range	0=low 1=high
7	spare	
8	hskp status parity	set to yield odd parity in bytes 1-6

|1|2|3|4|5|6|7|8| PPR Byte #4

Bit(s)	Measurement	Contents
1-8	temperature data MSBs	8 MSBs of temp data (12 bits total)

|1|2|3|4|5|6|7|8| PPR Byte #5

Table A2.10.1 PPR Instrument Status (MSB is bit 1)

Bit(s)	Measurement	Contents
1-4	temperature data LSBs	4 L.S.Bs of temp data (12 bits total)
5-8	temperature ID	0000=RCT-1 0001=RCT-R 0010=RCT-2 0011=PRM-1 0100=PRM-2 0101=SEM-1 0110=CHM-2 0111=RAS-1A 1000=RAS-1B 1001=RAS-2A 1010=RAS-2B 1011=BRREF 1100=SCBAF 1101=N/A 1110=N/A 1111=N/A

|1|2|3|4|5|6|7|8| PPR Byte #6

A2.10.4 Status and Science. The status and science section of the packet contains information used both for determining the health of the instrument, and for science purposes. The contents are shown in Table A2.10.2.

Table A2.10.2 Status and Science (MSB is bit 1)

Bit(s)	Measurement	Contents
1	rad data #1	for samples #1A and 1B 0=PP/PH scene science data 1=rad scene science data & science temperature
2-6	Filter/Retarder position #1	identifies the FRP position (0-31) corresponding to scene samples of bytes 8-10 (bit 2 is MSB)
7	calibration/boom tag #1	0=last sample pair taken during S/C roll with boom sequence operation active to serve as a separator for data taken on successive rolls. 1=1A and 1B data taken with internal or external cal lamp powered, or the 1st sample during a S/C roll with the boom sequence operation active
8	parity #1 (parity of science data bytes 7-10)	0=even parity 1=odd parity

|1|2|3|4|5|6|7|8| PPR Byte #7

A2.10.5 PPR Science Data 1A &1B. PPR Science Data 1A and 1B (bytes 7-10) contains Rad data, Filter/Retarder positions, calibration lamp status during the data period, boom tag information, 1A &1B parity (as shown in Table A2.10.2) plus 2 (12 bit) scene samples made up of 3 (8 bit) bytes as shown in Table A2.10.3.

Table A2.10.3 Science Data 1A & 1B (MSB is bit 1)

Bit(s)	Measurement	Contents
1-8	scene science sample #1A	8 MSBs of a 12 bit word denoting the 1st PP/PH scene science or radiation scene science sample

|1|2|3|4|5|6|7|8| PPR Byte #8

Table A2.10.3 Science Data 1A & 1B (MSB is bit 1)

Bit(s)	Measurement	Contents
1-4	scene science sample #1A (continued)	4 LSBs of a 12 bit word denoting the 1st PP/PH scene science or radiation scene science sample
5-8	scene science sample #1B	4 MSBs of a 12 bit word denoting the 2nd PP/PH scene science sample (of a simultaneously obtained sample pair) or a science temperature sample if 1A is sampling radiation

1 2 3 4 5 6 7 8 PPR Byte #9

Bit(s)	Measurement	Contents
1-8	scene science sample #1B (continued)	8 LSBs of a 12 bit word denoting the 2nd PP/PH scene science sample (of a simultaneously obtained sample pair) or a science temperature sample if 1A is sampling radiation

1 2 3 4 5 6 7 8 PPR Byte #10

A2.10.6 PPR Science Data 2A &2B. PPR Science Data 2A and 2B (bytes 11-14) contains data analogous to A2.10.5, Tables A2.10.2 and A2.10.3, denoting the second scene science sample pair of the PPR packet as shown in Figure A2.10.1.

A2.10.7 PPR Science Data 3A &3B. PPR Science Data 3A and 3B (bytes 15-18) contains data analogous to A2.10.5, Tables A2.10.2 and A2.10.3, denoting the third scene science sample pair of the PPR packet as shown in Figure A2.10.1.

A2.10.8 Telemetry Mode Changes. Upon application of system power, PPR shall configure itself to a normal operating mode. All data shall be valid.
Commanded telemetry mode changes are processed after completion of current mode data acquisition. Mode changes will occur at the start of a MOD 91 count.

A2.11 PLASMA WAVE SUBSYSTEM TELEMETRY

These paragraphs describe the format and content of the PWS output.

A2.11.1 PWS LRS Packet

The schematic of a PWS LRS packet is shown in Figure A2.11.1. 1 packet is placed in each LRS frame.

Title	Digital Status	Analog Engineering	Filter Channels	Data Quality	Waveform Survey Data
Data Offset	0	8	16	72	80
Bits/ packet	8	8	56	8	80
Descrip- tion	A2.11. 1.2	A2.11.1.3	A2.11.1.4	A2.11. 1.5	A2.11.1.6

Figure A2.11.1. PWS LRS Packet

A2.11.1.1 PWS LRS packet Synchronicity. Within the PWS LRS packet, there will exist two major synchronisms relative to the SCLK. The Digital Status, Analog Engineering, and Spectrum Analyzer Measurement filter channel synchronism relationship to SCLK is shown in Table A2.11.1, while the High Frequency filter channel, and Sweep Frequency Receiver relationship to SCLK is shown in Table A2.11.2.

Table A2.11.1 PWS SI vs. SCLK

SI	RIM (Modulo 4)	MOD 91
0	0	0,4,8,12,16,.......,88
	1	1,5,9,13,17,.......,89
	2	2,6,10,14,18,......,90
	3	3,7,11,15,19,......,87
1	0	1,5,9,13,17,.......,89
	1	2,6,10,14,18,......,90
	2	3,7,11,15,19,......,87
	3	0,4,8,12,16,.......,88
2	0	2,6,10,14,18,......,90
	1	3,7,11,15,19,......,87
	2	0,4,8,12,16,.......,88
	3	1,5,9,13,17,.......,89
3	0	3,7,11,15,19,......,87
	1	0,4,8,12,16,.......,88
	2	1,5,9,13,17,.......,89
	3	2,6,10,14,18,......,90

Table A2.11.2 High Frequency filter channel and Sweep Frequency Receiver
SI vs. SCLK

SI	RIM (Modulo 4)	MOD 91
0	0	0,28,56,84
	1	21,49,77
	2	14,42,70
	3	7,35,63
1	0	1,29,57,85
	1	22,50,78
	2	15,43,71
	3	8,36,64
2	0	2,30,58,86
	1	23,51,79
	2	16,44,72
	3	9,37,65
3	0	3,31,59,87
	1	24,52,80
	2	17,45,73
	3	10,38,66
4	0	4,32,60,88
	1	25,53,81
	2	18,46,74
	3	11,39,67
5	0	5,33,61,89
	1	26,54,82
	2	19,47,75
	3	12,40,68
6	0	6,34,62,90
	1	27,55,83
	2	20,48,76
	3	13,41,69

SI	RIM (Modulo 4)	MOD 91
7	0	7,35,63
	1	0,28,56,84
	2	21,49,77
	3	14,42,70
8	0	8,36,64
	1	1,29,57,85
	2	22,50,78
	3	15,43,71
9	0	9,37,65
	1	2,30,58,86
	2	23,51,79
	3	16,44,72
10	0	10,38,66
	1	3,31,59,87
	2	24,52,80
	3	17,45,73
11	0	11,39,67
	1	4,32,60,88
	2	25,53,81
	3	18,46,74
12	0	12,40,68
	1	5,33,61,89
	2	26,54,82
	3	19,47,75
13	0	13,41,69
	1	6,34,62,90
	2	27,55,83
	3	20,48,76

Table A2.11.2 High Frequency filter channel and Sweep Frequency Receiver
SI vs. SCLK

SI	RIM (Modulo 4)	MOD 91	SI	RIM (Modulo 4)	MOD 91
14	0	14,42,70	21	0	21,49,77
	1	7,35,63		1	14,42,70
	2	0,28,56,84		2	7,35,63
	3	21,49,77		3	0,28,56,84
15	0	15,43,71	22	0	22,50,78
	1	8,36,64		1	15,43,71
	2	1,29,57,85		2	8,36,64
	3	22,50,78		3	1,29,57,85
16	0	16,44,72	23	0	23,51,79
	1	9,37,65		1	16,44,72
	2	2,30,58,86		2	9,37,65
	3	23,51,79		3	2,30,58,86
17	0	17,45,73	24	0	24,52,80
	1	10,38,66		1	17,45,73
	2	3,31,59,87		2	10,38,66
	3	24,52,80		3	3,31,59,87
18	0	18,46,73	25	0	25,53,81
	1	11,39,67		1	18,46,74
	2	4,32,60,88		2	11,39,67
	3	25,53,81		3	4,32,60,88
19	0	19,47,75	26	0	26,54,82
	1	12,40,68		1	19,47,75
	2	5,33,61,89		2	12,40,68
	3	26,54,82		3	5,33,61,89
20	0	20,48,76	27	0	27,55,83
	1	13,41,69		1	20,48,76
	2	6,34,62,90		2	13,41,69
	3	27,55,83		3	6,34,62,90

A2.11.1.2 <u>Subcommutated Digital Status</u>. The PWS Subcommutated Digital Status section contains one byte (8-bits) of status data. This is shown in Table A2.11.3.

Table A2.11.3 Subcommutated Digital Status (MSB is bit 1)

Bit(s)	Measurement	Contents
1	antenna switch position	0=E 1=B
2-6	filter channel synchronization index	0-27 counter, 28-31=N/A
7	waveform command inhibit/enable	0=enable 1=inhibit
8	spectrum analyzer antenna switch	0=E 1=B

|1|2|3|4|5|6|7|8| SI=0

Bit(s)	Measurement	Contents
1	antenna switch position	0=E 1=B
2-6	filter channel synchronization index	0-27 counter, 28-31=N/A
7	antenna switch inhibit/cycle	0=cycle 1=inhibit
8	calibration enable/inhibit	0=inhibit 1=enable

|1|2|3|4|5|6|7|8| SI=1

Bit(s)	Measurement	Contents
1	antenna switch position	0=E 1=B
2-6	filter channel synchronization index	0-27 counter, 28-31=N/A
7	waveform select switch	0=E 1=B
8	waveform power	0=on 1=off

|1|2|3|4|5|6|7|8| SI=2

Bit(s)	Measurement	Contents
1	antenna switch position	0=E 1=B
2-6	filter channel synchronization index	0-27 counter, 28-31=N/A
7-8	waveform receiver mode	00=waveform survey 01=100.8 kbps 10=806.4 kbps 11=12.6 kbps

|1|2|3|4|5|6|7|8| SI=3

A2.11.1.3 <u>Analog Engineering</u>. The PWS analog engineering section contains one byte (8 bits) of subcommutated data. The contents are shown in Table A2.11.4.

Table A2.11.4 Analog Engineering (MSB is bit 1)

Bit(s)	Measurement	Contents
1-8	automatic gain control	0 to 5 volts

`|1|2|3|4|5|6|7|8|` SI=0

Bit(s)	Measurement	Contents
1-8	power supply monitor	0 to 5 volts

`|1|2|3|4|5|6|7|8|` SI=1

Bit(s)	Measurement	Contents
1-8	8 bit analog/digital converter reference 1	0 to 5 volts

`|1|2|3|4|5|6|7|8|` SI=2

Bit(s)	Measurement	Contents
1-8	4 bit analog/digital converter reference 2	0 to 5 volts

`|1|2|3|4|5|6|7|8|` SI=3

A2.11.1.4 <u>Filter Channels</u>. The Filter Channel section contains 7 bytes of subcommutated data. The contents are shown in Table A2.11.5. 1 byte (byte 4) of this is subcommutated Spectrum Analyzer data. This data is shown in Table A2.11.6. Another 2 bytes (3 and 7) are High Frequency receiver data. It is shown in Table A2.11.7. The other 4 bytes (1,2,5, and 6) are Sweep Frequency Receiver data. They are shown in Table A2.11.8.

Table A2.11.5 Filter Channels (MSB is bit 1)

Bit(s)	Measurement	Contents
1-8	sweep frequency receiver subcommutated data	See Table A2.11.8

`|1|2|3|4|5|6|7|8|` Byte 1

Bit(s)	Measurement	Contents
1-8	sweep frequency receiver subcommutated data	See Table A2.11.8

`|1|2|3|4|5|6|7|8|` Byte 2

Table A2.11.5 Filter Channels (MSB is bit 1)

Byte	Bit(s)	Measurement	Contents
Byte 3	1-8	high frequency subcommutated data	See Table A2.11.7
Byte 4	1-8	spectrum analyzer subcommutated data	See Table A2.11.6
Byte 5	1-8	sweep frequency receiver subcommutated data	See Table A2.11.8
Byte 6	1-8	sweep frequency receiver subcommutated data	See Table A2.11.8
Byte 7	1-8	high frequency subcommutated data	See Table A2.11.7

Table A2.11.6 Spectrum Analyzer Data

Spectrum Analyzer SI	Filter Number	Center Frequency (Hz)
0	4	31.1
1	3	17.8
2	2	10.0
3	1	5.62

Table A2.11.7. High Frequency Receiver Data

High Frequency Receiver SI	Receiver Center Frequency (MHz)	
	Byte 3	Byte 7
0	0.4032	0.1008
1	0.8060	0.1008
2	1.613	0.2016
3	3.226	0.2016
4	0.4536	0.1134
5	0.9070	0.1134
6	1.814	0.2268
7	3.629	0.2268
8	0.5040	0.1260
9	1.008	0.1260
10	2.016	0.2520
11	4.032	0.2520
12	0.5544	0.1386
13	1.109	0.1386
14	2.218	0.2772
15	4.435	0.2772
16	0.6048	0.1512
17	1.210	0.1512
18	2.419	0.3024
19	4.838	0.3024
20	0.6552	0.1638
21	1.310	0.1638
22	2.621	0.3276
23	5.242	0.3276
24	0.7056	0.1764
25	1.411	0.1764
26	2.822	0.3528
27	5.645	0.3528

Table A2.11.8 Sweep Frequency Receiver S.I. vs Filter

S.I.	S.F.R.* Byte 6 Filt. #	S.F.R.* Byte 6 Center Freq. (Hz)	S.F.R. Byte 5 Filt. #	S.F.R. Byte 5 Center Freq. (Hz)
0	1	42.1	29	337
1	2	45.6	30	364
2	3	49.0	31	392
3	4	52.5	32	420
4	5	56.0	33	448
5	6	59.6	34	476
6	7	66.7	35	534
7	8	70.4	36	563
8	9	77.7	37	622
9	10	81.5	38	652
10	11	89.0	39	712
11	12	96.7	40	774
12	13	104.5	41	836
13	14	112.5	42	900
14	15	120.6	43	965
15	16	128.9	44	1031
16	17	137.3	45	1098
17	18	150.2	46	1201
18	19	158.9	47	1272
19	20	172.5	48	1380
20	21	186.4	49	1491
21	22	200.7	50	1606
22	23	215.5	51	1724
23	24	235.9	52	1887
24	25	251.7	53	2013
25	26	268.0	54	2144
26	27	290.6	55	2325
27	28	314.1	56	2513

*Sweep Frequency Receeiver

Table A2.11.8 Sweep Frequency Receiver S.I. vs Filter

	S.F.R. Byte 2		S.F.R. Byte 1	
S.I.	Filt. #	Center Freq. (KHz)	Filt. #	Center Freq. (KHz)
0	57	2.70	85	21.6
1	58	2.91	86	23.3
2	59	3.14	87	25.1
3	60	3.36	88	26.9
4	61	3.58	89	28.7
5	62	3.81	90	30.5
6	63	4.27	91	34.2
7	64	4.50	92	36.0
8	65	4.98	93	39.8
9	66	5.21	94	41.7
10	67	5.70	95	45.6
11	68	6.19	96	49.5
12	69	6.69	97	53.5
13	70	7.20	98	57.6
14	71	7.72	99	61.7
15	72	8.25	100	66.0
16	73	8.78	101	70.3
17	74	9.61	102	76.9
18	75	10.17	103	81.4
19	76	11.04	104	88.3
20	77	11.93	105	95.4
21	78	12.85	106	102.8
22	79	13.79	107	110.3
23	80	15.09	108	120.7
24	81	16.11	109	128.9
25	82	17.15	110	137.2
26	83	18.59	111	148.8
27	84	20.10	112	160.8

A2.11.1.5 Data Quality. This word corresponds to the parity of the Digital Status, the Analog Engineering, and the Filter Channel sections. Each bit represents the parity of one of the 8 preceding words, with the MSB corresponding to the parity of the first word, and so on.

A2.11.1.6 Waveform Survey Data. The Waveform Survey Data section contains 10 bytes of sampled waveform receiver data. If the waveform receiver is in the survey mode (bits 7-8 for SI=2 in Table A2.11.3 equal to 0_{10}), the contents alternate between one sample of data collected at 100.8 Kb/s and one sample of data collected at 12.6 Kb/s, each of which is clocked out over 14 LRS frames. If bits 2-6 in Table A2.11.3 are 0_{10} to 13_{10}, the data is 12.6 Kb/s data. If bits 2-6 in Table A2.11.3 are 14_{10} to 27_{10}, the data is 100.8 Kb/s data.

If the waveform receiver is in the 12.6 Kb/s mode, the 100.8 Kb/s, or the 806.4 Kb/s mode (bits 7-8 for SI=2 in Table A2.11.3 equal to 3_{10} for 12.6 Kb/s, 1_{10} for 100.8 Kb/s, or 2_{10} for 806.4 Kb/s), the contents of the waveform section are one sample of data collected at the same rate as that of the waveform receiver mode clocked out over 14 LRS frames.

Each byte of waveform survey data consists of two 4-bit waveform samples.

A2.11.2 PWS MPW Packet

The schematic of a PWS Medium Rate PWS (MPW) packet is shown in Figure A2.11.2. 1 packet is placed in each MPW frame.

Title	Wideband Waveform Receiver Data
Data Offset	0
Bits/packet	512
Description	A2.11.2.2

Figure A2.11.2. PWS MPW Packet

A2.11.2.1 PWS MPW Packet Synchronicity. Within the PWS MPW packet, there will exist no synchronism.

A2.11.2.2 Wideband Waveform Receiver Data. This section contains data from the Wideband Waveform Receiver consisting of 128 words of 4 bits each, and is of three possible types. It can be data in the 5 Hz to 1 KHz range (outputting data at 12.6 kbps), the 50 Hz to 10 KHz range (outputting data at 100.8 kbps), or the 50 Hz to 80 KHz range (outputting data at 806.4 kbps). The data contents are determined from the status bits in the LRS packet, described in A2.11.1.2. All data is buffered by the CDS, placed into the data stream, with excess bits being discarded.

A2.11.3 PWS XPW Packet

The schematic of a PWS Intermediate Rate PWS (XPW) packet is shown in Figure A2.11.3. 1 packet is placed in each XPW frame.

Title	Wideband Waveform Receiver Data
Data Offset	0
Bits/ packet	3104
Description	A2.11.3.2

Figure A2.11.3. PWS XPW Packet

A2.11.3.1 PWS XPW Packet Synchronicity. Within the PWS XPW packet, there will exist no synchronism.

A2.11.3.2 Wideband Waveform Receiver Data. This section contains data from the Wideband Waveform Receiver consisting of 776 words of 4 bits each, and is of two possible types. It can be data in the 50 Hz to 10 KHz range (outputting data at 100.8 kbps), or the 50 Hz to 80 KHz range (outputting data at 806.4 kbps). The data contents are determined from the status bits in the LRS packet, described in A2.11.1.2. All data is buffered by the CDS, placed into the data stream, with excess bits being discarded.

A2.11.4 PWS HPW Packet

The schematic of a PWS High Rate PWS (HPW) packet is shown in Figure A2.11.4. 1 packet is placed in each HPW frame.

Title	Wideband Waveform Receiver Data
Data Offset	0
Bits/ packet	6304
Description	A2.11.4.2

Figure A2.11.4. PWS HPW Packet

A2.11.4.1 PWS HPW Packet Synchronicity. Within the PWS HPW packet, there will exist no synchronism.

A2.11.4.2 <u>Wideband Waveform Receiver Data</u>. This section contains data from the Wideband Waveform Receiver consisting of 1576 words of 4 bits each, and is of two possible types. It can be data in the 50 Hz to 10 KHz range (outputting data at 100.8 kbps), or the 50 Hz to 80 KHz range (outputting data at 806.4 kbps). The data contents are determined from the status bits in the LRS packet, described in A2.11.1.2. All data is buffered by the CDS, placed into the data stream, with excess bits being discarded.

A2.11.5 PWS PW4 Packet

The schematic of a PWS 403.2 kb/s PWS (PW4) packet is shown in Figure A2.11.5. 1 packet is placed in each PW4 frame.

Title	Wideband Waveform Receiver Data
Data Offset	0
Bits/ packet	3104
Description	A2.11.5.2

Figure A2.11.5. PWS PW4 Packet

A2.11.5.1 <u>PWS PW4 Packet Synchronicity</u>. Within the PWS PW4 packet, there will exist no synchronism.

A2.11.5.2 <u>Wideband Waveform Receiver Data</u>. This section contains data from the Wideband Waveform Receiver consisting of 776 words of 4 bits each. It is data in the 50 Hz to 80 KHz range (outputting data at 806.4 kbps). The data contents are determined from the status bits in the LRS packet, described in A2.11.1.2. All data is buffered by the CDS, placed into the data stream, with excess bits being discarded.

A2.11.6 PWS PW8 Packet

The schematic of a PWS 806.4 kb/s PWS (PW8) packet is shown in Figure A2.11.6. 1 packet is placed in each PW8 frame.

Title	Wideband Waveform Receiver Data
Data Offset	0
Bits/ packet	6400
Description	A2.11.6.2

Figure A2.11.6. PWS PW8 Packet

A2.11.6.1 PWS PW8 Packet Synchronicity. Within the PWS PW8 packet, there will exist no synchronism.

A2.11.6.2 Wideband Waveform Receiver Data.

This section contains data from the Wideband Waveform Receiver consisting of 1600 words of 4 bits each. It is data in the 50 Hz to 80 KHz range (outputting data at 806.4 kbps). The data contents are determined from the status bits in the LRS packet, described in A2.11.1.2. All data is buffered by the CDS, placed into the data stream, with excess bits being discarded.

A2.11.7 PWS MPP Packet

The schematic of a PWS Medium rate PWS (MPP) packet is shown in Figure A2.11.7. A single packet is placed in each MPP frame.

Title	Wideband Waveform Receiver Data
Data Offset	0
Bits/ packet	1280
Description	A2.11.7.2

Figure A2.11.7. PWS MPP Packet

A2.11.7.1 PWS MPP Packet Synchronicity. Within the PWS/MPP packet, there will exist no synchronism.

A2.11.7.2 Wideband Waveform Receiver Data. This section contains data from the Wideband Waveform Receiver consisting of 320 words of 4 bits each, and is of three possible types. It can be data in the 5 Hz to 1 KHz range (outputting data at 100.8 Kbps). The data contents are determined from the status bits in the LRS packet, described in A2.11.1.2. All data is buffered by the CDS, placed into the data stream, with excess bits being discharged.

A2.11.8 PWS HCJ Packet

The schematic of a PWS High rate PWS (HCJ) packet is shown in Figure A2.11.8. 1 packet is placed in each HCJ frame.

Title	Wideband Waveform Receiver Data
Data Offset	0
Bits/ packet	864
Description	A2.11.8.2

Figure A2.11.8. PWS HCJ Packet

A2.11.8.1 PWS HCJ Packet Synchronicity. Within the PWS HCJ packet, there will exist no synchronism.

A2.11.8.2 Wideband Waveform Receiver Data. This section contains data from the Wideband Waveform Receiver consisting of 216 words of 4 bits each, and is of three possible types. It can be data in the 5Hz to 1 KHz range (outputting data at 12.6 kbps), the 50 Hz to 10 KHz range (outputting data at 100.8 kbps), or the 50 Hz to 80 KHz range (outputting data at 806.4 kbps). The data contents are determined from the status bits in the LRS packet, described in A2.11.1.2. All data is buffered by the CDS, placed into the data stream, with excess bits being discharged.

A2.11.9 PWS HPJ Packet

The schematic of a PWS High rate PWS (HPJ) packet is shown in Figure A2.11.9. 1 packet is placed in each HPJ frame.

Title	Wideband Waveform Receiver Data
Data Offset	0
Bits/ packet	864
Description	A2.11.9.2

Figure A2.11.9. PWS HPJ Packet

A2.11.9.1 PWS HPJ Packet Synchronicity. Within the PWS HPJ packet, there will exist no synchronism.

A2.11.9.2 Wideband Waveform Receiver Data. This section contains data from the Wideband Waveform Receiver consisting of 216 words of 4 bits each, and is of three possible types. It can be data in the 5 Hz to 1 KHz range (outputting data at 12.6 kbps), or the 50 Hz to 10 KHz range (outputting data at 100.8 kbps), or the 50 Hz to 80 KHz range (outputting data at 806.4 kbps). The data contents are determined from the status bits in the LRS packet, described in A2.11.1.2. All data is buffered by the CDS, placed into the data stream, with excess bits being discharged.

A2.12 SOLID STATE IMAGING SUBSYSTEM TELEMETRY

This paragraph describes the format and content of the SSI output, both to the LRS data stream via the Data System Bus and to the DBUM via the high rate interface.

A2.12.1 SSI LRS Packet. The schematic of this packet is shown in Figure A2.12.1. Three identical SSI LRS packets are placed in each LRS frame, 96 bits per LRS frame.

Title	Standard Housekeeping Data	2 1/3 Second Imaging Housekeeping Data
Data Offset	0	16
Bits/packet	16	16
Description	A2.12.1.2	A2.12.1.3

Figure A2.12.1 SSI LRS Packet

A2.12.1.1 Instrument Synchronicity. Within the SSI LRS packet, there will exist two major synchronisms relative to the SCLK. The relationship of the Synchronization Index's to MOD 91 count is shown in Table A2.12.1.

Table A2.12.1 Relationship of SI's to MOD 91

Standard Imaging SI	MOD 91
0	0, 13, 26, 39, 52, 65, 78
1	1, 14, 27, 40, 53, 66, 79
2	2, 15, 28, 41, 54, 67, 80
3	3, 16, 29, 42, 55, 68, 81
4	4, 17, 30, 43, 56, 69, 82
5	5, 18, 31, 44, 57, 70, 83
6	6, 19, 32, 45, 58, 71, 84
7	7, 20, 33, 46, 59, 72, 85
8	8, 21, 34, 47, 60, 73, 86
9	9, 22, 35, 48, 61, 74, 87
10	10, 23, 36, 49, 62, 75, 88
11	11, 24, 37, 50, 63, 76, 89
12	12, 25, 38, 51, 64, 77, 90

Table A2.12.1 Relationship of SI's to MOD 91

2 1/3 Second Imaging SI	MOD 91
0	0, 7, 14, 21, 28, 35, 42, 49, 56, 63, 70, 77, 84
1	1, 8, 15, 22, 29, 36, 43, 50, 57, 64, 71, 78, 85
2	2, 9, 16, 23, 30, 37, 44, 51, 58, 65, 72, 79, 86
3	3, 10, 17, 24, 31, 38, 45, 52, 59, 66, 73, 80, 87
4	4, 11, 18, 25, 32, 39, 46, 53, 60, 67, 74, 81, 88
5	5, 12, 19, 26, 33, 40, 47, 54, 61, 68, 75, 82, 89
6	6, 13, 20, 27, 34, 41, 48, 55, 62, 69, 76, 83, 90

A2.12.1.2 <u>SSI Standard Housekeeping Data</u>. The SSI Standard Housekeeping Data section contains 26 data words which are commutated into the first two (of four) data bytes in each LRS Frame, as shown in Table A2.12.2. The contents of the SSI Housekeeping Data words are shown in Table A2.12.3. The subcommutated housekeeping data is shown in Table A2.12.4.

Table A2.12.2 SSI Standard Housekeeping vs. SI(MSB is bit 1)

Standard Imaging SI	Byte 1	Byte 2
0	Data Word 1	Data Word 2
1	Data Word 3	Data Word 4
2	Data Word 5	Data Word 6
3	Data Word 7	Data Word 8
4	Data Word 9	Data Word 10
5	Data Word 11	Data Word 12
6	Data Word 13	Data Word 14
7	Data Word 15	Data Word 16
8	Data Word 17	Data Word 18
9	Data Word 19	Data Word 20
10	Data Word 21	Data Word 22
11	Data Word 23	Data Word 24
12	Data Word 25	Data Word 26

Table A2.12.3 SSI Housekeeping Data (MSB is bit 1)

Bit(s)	Measurement	Contents
1-8	subcommutated data	

|1|2|3|4|5|6|7|8| SSI Housekeeping Data Word 1

Bit(s)	Measurement	Contents
1-8	programmed memory word readout	DN of word addressed by readout

|1|2|3|4|5|6|7|8| SSI Housekeeping Data Word 2

Table A2.12.3 SSI Housekeeping Data (MSB is bit 1)

Bit(s)	Measurement	Contents
1	engineering sample mode	0=normal 1=programmed
2	spare	
3	light flood internal disable	0=enabled 1=disabled
4	light flood status	0=off 1=on
5-8	programmed engrng channel: if engrng sample mode is programmed, data in words 6 through 21 are replaced with 16 samples of the indicated measurement	0000=word 6 0001=word 7 0010=word 8 0011=word 9 0100=word 10 0101=word 11 0110=word 12 0111=word 13 1000=word 14 1001=word 15 1010=word 16 1011=word 17 1100=word 18 1101=word 19 1110=word 20 1111=word 21

|1|2|3|4|5|6|7|8| SSI Housekeeping Data Word 3

Bit(s)	Measurement	Contents
1-8	engineering start time	0-129 RTI

|1|2|3|4|5|6|7|8| SSI Housekeeping Data Word 4

Bit(s)	Measurement	Contents
1	bus parity error detected	0=no error detected 1=error detected
2	state vector control program links	0=ROM links 1=scratchpad links
3	state vector control program memory status	0=ROM 1=RAM
4	state vector control scratchpad status	0=scratchpad 1 1=scratchpad 2
5	timing sync error	0=no error detected 1=error detected
6	unrecognized cmd detected	0=no error detected 1=error detected
7	secondary scratchpad error	0=no error detected 1=error detected
8	primary scratchpad error (SP1)	0=no error detected 1=error detected

|1|2|3|4|5|6|7|8| SSI Housekeeping Data Word 5

Table A2.12.3 SSI Housekeeping Data (MSB is bit 1)

Word	Bit(s)	Measurement	Contents
SSI Housekeeping Data Word 5 (continued)	1-8	input current	0 to 512 ma rms
SSI Housekeeping Data Word 6	1-8	+50 Vdc	0 to 61 Vdc
SSI Housekeeping Data Word 7	1-8	+15 Vdc	0 to 22 Vdc
SSI Housekeeping Data Word 8	1-8	-15 Vdc	0 to -22 Vdc
SSI Housekeeping Data Word 9	1-8	+10 Vdc	0 to 16 Vdc
SSI Housekeeping Data Word 10	1-8	+5 Vdc	0 to 10 Vdc
SSI Housekeeping Data Word 11	1-8	-5 Vdc	0 to -10 Vdc
SSI Housekeeping Data Word 12	1-8	CCD heater voltage	0 to 14 Vdc
SSI Housekeeping Data Word 13	1-8	CCD temperature, fine	-97.2 to -122.8 deg. C
SSI Housekeeping Data Word 14	1-8	baseline correction volts	-7.5 to +7.5 Vdc

|1|2|3|4|5|6|7|8| SSI Housekeeping Data Word 15

Table A2.12.3 SSI Housekeeping Data (MSB is bit 1)

Word	Bit(s)	Measurement	Contents
SSI Housekeeping Data Word 16	1-8	ADC reference volts	0 to -15.3 Vdc
SSI Housekeeping Data Word 17	1-8	VDD	0 to 42.6 Vdc
SSI Housekeeping Data Word 18	1-8	VREF	0 to 42.6 Vdc
SSI Housekeeping Data Word 19	1-8	CCD temp, coarse	+55 to -150 degrees C
SSI Housekeeping Data Word 20	1-8	positive clock volts	0 to +15.2 Vdc
SSI Housekeeping Data Word 21	1-8	negative clock volts	0 to -32.0 Vdc
SSI Housekeeping Data Word 22	1-8	picture count	increments every non-zero exposure and dark current calibration
SSI Housekeeping Data Word 23	1-8	image parameters 1	cmd echo of image param.
SSI Housekeeping Data Word 24	1-8	image parameters 2	cmd echo of image param.

Table A2.12.3 SSI Housekeeping Data (MSB is bit 1)

SSI Housekeeping Data Word 25

Bit(s)	Measurement	Contents
1-2	imaging mode	00=60-2/3 s 01=8-2/3 s 10=30-1/3 s 11=2-1/3 s
3	exposure mode	0=normal 1=extended
4	long exposure cycle	0=cycle 1 1=cycle 2
5	compression mode	0=rate controlled 1=information preserving
6	image compressor	0=compressor out 1=compressor in
7-8	gain	00=gain 1 01=gain 2 10=gain 3 11=gain 4

|1|2|3|4|5|6|7|8| SSI Housekeeping Data Word 25

Bit(s)	Measurement	Contents
1	memory write protect	0=write protect off 1=write protect on
2	parallel clock state	0=normal 1=inverted
3	watchdog timer	0=not tripped 1=tripped
4	blemish protection	0=off 1=on
5-7	actual filter position	position 0 through 7
8	filter pstn parity	odd parity

|1|2|3|4|5|6|7|8| SSI Housekeeping Data Word 26

Table A2.12.4 SSI Subcommutated Housekeeping Data (MSB is bit 1)

Bit(s)	Measurement	Contents
1-8	MS byte programmed memory word address	

|1|2|3|4|5|6|7|8| MOD91=0 Subcommutated SSI Housekeeping Data Word 1

Bit(s)	Measurement	Contents
1-8	LS byte programmed memory word address	

|1|2|3|4|5|6|7|8| MOD91=13 Subcommutated SSI Housekeeping Data Word 1

Table A2.12.4 SSI Subcommutated Housekeeping Data (MSB is bit 1)

```
                       Bit(s)     Measurement          Contents
                      ----------------------------------------------------
      ------------- |1-4|parity error count   |count of parity errors   |
      |       ----- |5-8|unrecognized cmd     |count of unrecognized    |
    --|--   --|--   |___|count________________|commands_________________|
    |_____|_|_____|
|1|2|3|4|5|6|7|8| MOD91=26 Subcommutated SSI Housekeeping Data Word 1

                      ----------------------------------------------------
        --------- |1-8|MS byte SSI transfer |MS byte, number of bytes|
    ------|------   |___|count________________|received from CDS________|
    |_____________|
|1|2|3|4|5|6|7|8| MOD91=39 Subcommutated SSI Housekeeping Data Word 1

                      ----------------------------------------------------
        --------- |1-8|LS byte SSI transfer |LS byte, number of bytes|
    ------|------   |___|count________________|received from CDS________|
    |_____________|
|1|2|3|4|5|6|7|8| MOD91=52 Subcommutated SSI Housekeeping Data Word 1

                      ----------------------------------------------------
        --------- |1-8|primary program      |result of ROM checksum   |
    ------|------   |___|memory checksum (ROM)|_________________________|
    |_____________|
|1|2|3|4|5|6|7|8| MOD91=65 Subcommutated SSI Housekeeping Data Word 1

                      ----------------------------------------------------
        --------- |1-8|secondary program    |result of RAM checksum   |
    ------|------   |___|memory checksum (RAM)|_________________________|
    |_____________|
|1|2|3|4|5|6|7|8| MOD91=78 Subcommutated SSI Housekeeping Data Word 1
```

A2.12.1.3 SSI 2 1/3 Second Imaging Housekeeping Data. When the SSI is in the 2 1/3 Second Imaging mode (word 25, bits 1-2=11), the SSI 2 1/3 Second Imaging Housekeeping Data section contains 5 data words (from Table A2.12.3) which are commutated into the second two (of four) data bytes in each LRS Frame, as shown in Table A2.12.5. When the SSI is not in the 2 1/3 Second Imaging mode, the SSI 2 1/3 Second Imaging Housekeeping Data section contents are invalid.

Table A2.12.5 SSI 2 1/3 Second Imaging Housekeeping vs. SI(MSB is bit 1)

2 1/3 Second Imaging SI	Byte 3	Byte 4
0	Data Word 22	Data Word 23
1	Data Word 24	Data Word 25
2	Data Word 26	spare
3	spare	spare
4	Data Word 22	Data Word 23
5	Data Word 24	Data Word 25
6	Data Word 26	spare

A2.12.1.4 Telemetry Mode Changes. Upon the application of system power, SSI shall assume a valid imaging mode, with the microprocessor configured to ROM program and scratchpad memory one. The SSI shall inhibit shuttering, filter wheel stepping, and insure that the shutter is closed until valid commanding takes place. Upon the removal of system power, the SSI shall prevent shuttering, filter wheel stepping, and insure that the shutter is closed.
Commanded telemetry mode changes shall be processed every RTI. Telemetry imaging mode changes shall occur at the beginning of a RIM.

A2.12.2 SSI 67.2 kbps XCM Packet. The schematic of this packet is shown in Figure A2.12.2. One SSI 67.2 kbps XCM packet is divided among 910 67.2 kbps frames (one image line per frame).

Title	Last line of previous Image	Fill Data	Subsequent Image Lines
Data Offset	0	3104	344544
Bits/packet	3104 (line 0)	341440 (1-110)	2480096 (111-909)
Description	A2.12.2.4	A2.12.2.2	A2.12.2.4

Figure A2.12.2 SSI 67.2 kbps XCM Packet

A2.12.2.1 Instrument Synchronicity. Within the SSI 67.2 kbps XCM packet, there will exist no major synchronism relative to the SCLK.

A2.12.2.2 Fill Data. This section contains fill data composed of data already present in the data buffers.

A2.12.2.3 Deleted.

A2.12.2.4 Image Data Section. This section contains image data in a compressed format. Each 3104 bits of a 67.2 kbps frame consists of 2592 bits of compressed image data, and 512 bits of Reed-Solomon parity symbols. Because of compressed line timing delays, the last line of each image is delayed until the start of the following packet.

A2.12.2.5 Compressed Image Data. The compressed image data consists of data which has undergone BARC data compression, either in a rate controlled mode, or an information preserving mode.

A2.12.2.6 Reed-Solomon Coding Function. A J=8, E=16, I=2 Reed-Solomon code, together with a K=7, R=1/2 convolutional code, is employed to construct a concatenated Imaging data channel. The performance of the code is such that the coded imaging data will be delivered to the users with a bit error rate of $\leq 5 \times 10^{-6}$ even though the overall high rate channel is operated at a bit error rate of $\leq 5 \times 10^{-3}$.

A2.12.2.7 Extended Exposure Mode. In the Extended Exposure Mode, two packets of image data are required for each image. The first packet will contain data as specified before, but the first packet's image data will not be valid (i.e. it will contain fill data), and the image data will all be present in the second packet's image data area.

A2.12.2A SSI 67.2 kbps XED Packet. The schematic of this packet is shown in Figure A2.12.2A. One SSI 67.2 kbps XED packet is divided among 910 67.2 kbps frames (one image line per frame).

Title	Last line of previous Image 2	Fill Data	First line of Image 1	Subsequent Image Lines Section 1	Fill Data	First line of Image 2	Subsequent Image Lines Section 2
Data Offset	0	3104	170720	176928	1415424	1583040	1589248
Bits/ packet	3104 (line 0)	167616 (1-54)	3104 (55)	1238496 (56-455)	167616 (456-509)	3104 (510)	1235392 (511-909)
Descri- ption	A2.12.2A.4	A2.12.2A.2	A2.12.2A.4	A2.12.2A.4	A2.12.2A.2	A2.12.2A.4	A2.12.2A.4

Figure A2.2.12.2A SSI 67.2 kbps XED Packet

A2.12.2A.1 Instrument Synchronicity. Within the SSI 67.2 kbps XED packet, there will exist no major synchronism relative to the SCLK.

A2.12.2A.2 Fill Data. This section contains fill data composed of data already present in the data buffers.

A2.12.2A.3 Deleted.

A2.12.2A.4 Image Data Section. This section conntains image data in an edited and compressed format. Each 3104 bits of data consists of 2592 bits of compressed image data which is also edited, and 512 bits of Reed-Solomon parity symbols. The sets of compressed image data and Reed-Solomon parity symbols are described in paragraph A2.12.2.4 and A2.12.2.5. The first line consists of the normally edited odd line of the first line pair. Subsequent odd lines are edited out by the CDS.

A2.12.2A.5 Extended Exposure Mode. In the Extended Exposure Mode, two packets of image data are required for each image. The first packet will conntain data as specified before, but the first packet's image data will not be valid (i.e. it will contain fill data), and the image data will all be present in the second packet's image data area.

A2.12.3 SSI 115.2 kbps Standard Imaging Packet. The schematic of this packet is shown in Figure A2.12.4. One SSI 115.2 kbps standard imaging packet is divided among 910 115.2 kbps frames (one image line per frame).

Title	Fill Data	Image Data Section
Data Offset	0	693440
Bits/packet	693440 (lines 0-109)	5043200 (lines 110-909)
Description	A2.12.3.2	A2.12.3.4

Figure A2.12.4 SSI 115.2 kbps Packet

A2.12.3.1 Instrument Synchronicity. Within the SSI 115.2 kbps standard imaging packet, there will exist no major synchronism relative to the SCLK.

A2.12.3.2 Fill Data. This section contains fill data composed of data already present in the data buffers.

A2.12.3.3 Deleted

A2.12.3.4 Image Data Section. This section contains standard imaging. Each 6304 bits of data makes up one line of an image. Each 8 bits of data corresponds to one pixel of the image. .pa

A2.12.3.5 Extended Exposure Mode. In the Extended Exposure Mode, two packets of image data are required for each image. The first packet will contain data as specified before, but the first packet's image data will not be valid (i.e. it will contain fill data), and the image data will all be present in the second packet's image data area.

A2.12.4 SSI 115.2 kbps Compressed Imaging Packet. The schematic of this packet is shown in Figure A2.12.6. One SSI 115.2 kbps compressed imaging packet is divided among 910 115.2 kbps frames (two image lines per frame).

Title	Last line of previous image 2	Fill Data	First line of image 1	Fill Data	Subsequent Image Lines Section 1	Last line of Image 1	Fill Data	First line of Image 2	Fill Data	Subsequent Image Lines Section 2
Data Offset	0	3104	346720	349824	353024	2871424	2871424	3215040	3218144	3221344
Bits/ Packet	3104 (line 0)	343616 (last half of line 0-54)	3104 (55)	3200 (last half of line 55)	2515296 (56-454)	3104 (455)	343616 (last half of line 455-509)	3104 (510)	3200 (last half of line 510)	2515296 (511-909)
Descri- ption	A2.12.4.4	A2.12.4.2	A2.12.4.4	A2.12.4.2	A2.12.4.4	A2.12.4.4	A2.12.4.5	A2.12.4.7	A2.12.4.5	A2.12.4.7

Figure A2.12.6 SSI 115.2 kbps Compressed Imaging Packet

A2.12.4.1 <u>Instrument Synchronicity</u>. Within the SSI 115.2 kbps compressed imaging packet, there will exist no major synchronism relative to the SCLK.

A2.12.4.2 <u>Fill Data</u>. This section contains fill data composed of data already present in the data buffers.

A2.12.4.3 Deleted

A2.12.4.4 <u>Image Data Section #1</u>. This section contains compressed imaging. Each 115.2 kbps frame of imaging data contains 2 sets of compressed image data (2592 bits) and Reed-Solomon parity symbols (512 bits), and filler data (96 bits). Each of the sets of compressed image data and Reed-Solomon parity symbols is as described in paragraph A2.12.2.5 and A2.12.2.6. Because of compressed line timing delays, each line of each image is delayed one line time.

A2.12.4.5 <u>Fill Data</u>. This section contains fill data composed of data already present in the data buffers.

A2.12.4.6 Deleted

A2.12.4.7 <u>Image Data Section #2</u>. This section contains compressed imaging. Each 115.2 kbps frame of imaging data contains 2 sets of compressed image data (2592 bits) and Reed-Solomon parity symbols (512 bits), and filler data (96 bits). Each of the sets of compressed image data and Reed-Solomon parity symbols is as described in paragraph A2.12.2.5 and A2.12.2.6. Because of compressed line timing delays, each line of each image is delayed one line time, and the last line of each packet is delayed until the start of the following packet.

A2.12.4.8 <u>Extended Exposure Mode</u>. In the Extended Exposure Mode, two groups of image data are required for each image. The first group will contain data as specified before, but the first group's image data will not be valid (i.e. it will contain fill data), and the image data will all be present in the second group's image data area.

A2.12.5 <u>SSI 403.2 kbps Compressed Imaging Packet</u>. The schematic of this packet is shown in Figure A2.12.8. One SSI 403.2 kbps compressed imaging packet is divided among 7280 403.2 kbps frames.

Title	Image #1	Image #2	Image #3	Image #4	Image #5	Image #6	Image #7
Start Bit	1	3228161	6456321	9684481	12912641	16140801	19368961
Stop Bit	3228160	6456320	9684480	12912640	16140800	19368960	22597120

Figure A2.12.8 SSI 403.2 kbps Compressed Imaging Packet

Seven images are in each packet. The relationship between the start of each image, and the SCLK is shown in Table A2.12.4.

Table A2.12.4 Relationship of MOD 91 to start of Image

Image Start	MOD 91
Image #1	0
Image #2	13
Image #3	26
Image #4	39
Image #5	52
Image #6	65
Image #7	78

The format of each image is shown in Figure A2.12.9.

Title	Last line of previous Image	Fill Data	Image Data Section
Bits/image	3104 (line 0)	744960 (lines 1-240)	2480096 (lines 241-1039)
Description	A2.12.5.4	A2.12.5.2	A2.12.5.4

Figure A2.12.9 SSI 403.2 kbps Image Area

A2.12.5.1 Instrument Synchronicity. Within the SSI 403.2 kbps standard imaging packet, there will exist no major synchronism relative to the SCLK.

A2.12.5.2 Fill Data. This section contains fill data composed of data already present in the data buffers.

A2.12.5.3 Deleted

A2.12.5.4 Image Data Section. This section contains compressed imaging. Each 3104 bits of data contains 2592 bits of compressed image data and 512 bits of Reed-Solomon parity symbols. Each of the sets of compressed image data and Reed-Solomon parity symbols is as described in paragraph A2.12.2.5 and A2.12.2.6. Because of delays in compressed line timing, the last line of each image is delayed until the start of the following Image Area.

A2.12.5.5 Extended Exposure Mode. In the Extended Exposure Mode, two groups of image data are required for each image. The first group will contain data as specified before, but the first group's image data will not be valid (i.e. it will contain fill data), and the image data will all be present in the second group's image data area.

A2.12.6 SSI 806.4 kbps Standard Imaging Packet. The schematic of this packet is shown in Figure A2.12.11. One SSI 806.4 kbps standard imaging packet is divided among 7280 806.4 kbps frames.

Title	Image #1	Image #2	Image #3	Image #4	Image #5	Image #6	Image #7
Start Bit	1	6656001	13312001	19968001	26624001	33280001	39936001
Stop Bit	6656000	13312000	19968000	26624000	33280000	39936000	46592000

Figure A2.12.11 SSI 806.4 kbps Standard Imaging Packet

Seven images are in each packet. The relationship between the start of each image, and the SCLK is shown in Table A2.12.4.

The format of each image is shown in Figure A2.12.12.

Title	Fill Data	Image Data Section
Bits/image	1536000 (lines 0-239)	5120000 (lines 240-1039)
Description	A2.12.6.2	A2.12.6.4

Figure A2.12.12 SSI 806.4 kbps Image Area

A2.12.6.1 Instrument Synchronicity. Within the SSI 806.4 kbps standard imaging packet, there will exist no major synchronism relative to the SCLK.

A2.12.6.2 Fill Data. This section contains fill data composed of data already present in the data buffers.

A2.12.6.3 Deleted

A2.12.6.4 Image Data Section. This section contains standard imaging. Each 6400 bits of data makes up one line of an image. Each 8 bits of image data makes up one pixel of image data.

A2.12.6.5 Extended Exposure Mode. In the Extended Exposure Mode, two groups of image data are required for each image. The first group will contain data as specified before, but the first groups image data will not be valid (i.e. it will contain fill data), and the image data will all be present in the second groups image data area.

A2.12.7 SSI 806.4 kbps Averaged Imaging Packet. The schematic of this packet is shown in Figure A2.12.14. One SSI 806.4 kbps averaged imaging packet is divided among 7280 806.4 kbps frames.

Title	26 Averaged Images
Data Offset	0
Bits/packet	46592000

Figure A2.12.14 SSI 806.4 kbps Averaged Imaging Packet

Twenty six images are in each packet. The relationship between the start of each image, and the SCLK is shown in Table A2.12.6.

Table A2.12.6. SCLK vs. Image Start

Image Start	MOD91
1	0
2	4
3	7
4	11
5	14
6	18
7	21
8	25
9	28
10	32
11	35
12	39
13	42
14	46
15	49
16	53
17	56
18	60
19	63
20	67
21	70
22	74
23	77
24	81
25	84
26	88

The format of each odd image is shown in Figure A2.12.15, and the format of each even image is shown in Figure A2.12.16.

Title	Fill Data	Image Data Section	Fill Data
Bits/image	512000 (lines 0-159)	1280000 (lines 160-559)	256000 (lines 560-639)
Description	A2.12.7.2	A2.12.7.4	A2.12.7.2

Figure A2.12.15 SSI 806.4 kbps Averaged Image Area (odd image)

Title	Fill Data	Image Data Section
Bits/image	256000 (lines 0-79)	1280000 (lines 80-479)
Description	A2.12.7.2	A2.12.7.4

Figure A2.12.16 SSI 806.4 kbps Averaged Image Area (even image)

A2.12.7.1 Instrument Synchronicity. Within the SSI 806.4 kbps averaged imaging packet, there will exist no major synchronism relative to the SCLK.

A2.12.7.2 Fill Data. This section contains fill data composed of data already present in the data buffers.

A2.12.7.3 Deleted

A2.12.7.4 Image Data Section. This section contains standard imaging. Each 3200 bits of data makes up one line of an image. Each 8 bits of image data makes up one pixel of image data.

A2.12.7.5 Extended Exposure Mode. In the Extended Exposure Mode, two groups of image data are required for each image. The first group will contain data as specified before, but the first groups image data will not be valid (i.e. it will contain fill data), and the image data will all be present in the second groups image data area.

A2.13 ULTRAVIOLET SPECTROMETER SUBSYSTEM TELEMETRY

These paragraphs describe the format and content of the UVS output.

A2.13.1 UVS Packet. The schematic of the UVS packet is shown in Figure A2.13.1. 6.5 LRS frames are required to transport 1 UVS packet (scan).

Title	Sync Code	Digital Status	Analog Eng.	UVS Sci. Data
Data offset	0	56	80	144
Bits/packet	56	24	64	4224
Description	A2.13.3	A2.13.4	A2.13.5	A2.13.6

Figure A2.13.1. UVS Packet (scan)

A2.13.2 Instrument Synchronicity. There are 14 UVS packets (scans) per RIM. The first LRS frame of each RIM is all zero's. The first UVS data scan then starts in the second LRS frame, and the 14th UVS data scan is truncated by one LRS frame. The relationship between the start of the UVS packet and the Synchronization Index and SCLK is shown in Table A2.13.1. The length of the scan (4-1/3 sec) is chosen to coincide with the NIMS scan.

Table A2.13.1 UVS packet start vs. SCLK

Bit 1 of UVS packet within packet position in LRS frame

SI	MOD 91	Byte
1	1	1
2	7	43
3	14	1
4	20	43
5	27	1
6	33	43
7	40	1
8	46	43
9	53	1
10	59	43
11	66	1
12	72	43
13	79	1
14	85	43

A2.13.3 Sync Code. The contents of the sync code section are 7 bytes of sync words. Each byte is a 1111 1111.

A2.13.4 Digital Status. The contents of the digital status section are shown in Table A2.13.2.

Table A2.13.2 UVS Digital Status (MSB is bit 1)

Bit(s)	Measurement	Contents
1-8	Starting wavelength	wavelength 0-255

|1|2|3|4|5|6|7|8| UVS Byte #8

Bit(s)	Measurement	Contents
1	F-detector status	0 = off 1 = on
2	N-detector status	0 = off 1 = on
3	G-detector status	0 = off 1 = on
4	F-detector high voltage status	0 = on 1 = off
5	N-detector high voltage status	0 = on 1 = off
6	G-detector high voltage status	0 = on 1 = off
7-8	Integration time	00= short (approx. 2 ms) 01= long (approx. 6 ms) 10= short (approx. 1 ms) 11= long (approx. 4 ms)

|1|2|3|4|5|6|7|8| UVS Byte #9

Bit(s)	Measurement	Contents
1	Wavelength scan	0 = scan grating 1 = fix grating
2-3	Wavelength monitored	00= first position monitored (or scanning if mode=0) 01= second position monitored 10= third position monitored 11= fourth position monitored
4	Grating	0 = motor control grating #1 1 = motor control grating #2
5	Micro-P control	0 = (cold start) UVS not under microprocessor control 1 = UVS under micro-processor control
6	Detectors high voltage state	0 = HV on for selected channel 1 = HV off for all channels
7	stim lamp status	0 = off 1 = on
8	limb override/sensor status	0 = override off 1 = override on

|1|2|3|4|5|6|7|8| UVS Byte #10

A2.13.5 Analog Engineering Status. The contents of the analog engineering status section are shown in Table A2.13.3

Table A2.13.3 UVS Analog Engineering Status

Byte	Measurement
11	low voltage +10 v.
12	low voltage +5 v.
13	high voltage F
14	high voltage N
15	high voltage G
16	logic temperature
17	detector temperature
18	limb sensor

A2.13.6 UVS Science Data. The N and G channels consist of 8 bit linear count data. The F channel is a 15 bit data word log compressed to 8 bit count data. The algorithms for the data compression and reconstruction are show in Figure A2.13.2. The science data for one UVS packet (scan) consists of 528 (8 bit) bytes read consecutively, beginning with byte 19 bit 1 of the packet (scan). Each 4-1/3 sec. packet (scan) contains data from one sensor only (N, G, or F). The engineering parameter, Table A2.13.2 byte 9, bits 1-3, at the beginning of each packet (scan) tells which sensor is active during that scan.

Compression

```
MSB            N              LSB               MSB  X       C  LSB
|1                            15|  --------->   |1      4|5      8|
     Binary input word                             UVS data word
      N=0 to 32,767                       X=4 bit power of 2 exponent
                                     C=4 bit fraction (1 bit hidden)
```

Algorithm: for N=0 $X=C=0$

for N>0 $X=\mathrm{Integer}\,[\log_2(N)+1]$

$C=\mathrm{Integer}\,[(N)(2)^{(5-x)}-2^4]$

Decompression

```
    X        C                               N
|1     4|5      8|   ------->   |1                                15|
   UVS data word                       Binary input word
```

Alorithm: $N=\mathrm{Integer}\,[(C+2^4)(2)^{(X-5)}+(2)^{(X-6)}]$

Figure A2.13.2
UVS compression/decompression Process

A2.13.7 Telemetry Mode Changes. Upon application of system power, UVS shall automatically configure itself to an operational mode identical to paragraph A2.13.1. All data shall be valid, but not sychronized to RTI or RIM. The 4-1/3 sec. packet (scan) can start at any byte boundary within any LRS MOD 91 count, therefore table A2.13.1 does not apply during POR (power on reset).

Commanded telemetry mode changes are processed every RIM. Mode changes data update shall occur one LRS frame after the start of a RIM.

A2.14 **RELAY RADIO HARDWARE**

These paragraphs describe the format and content of the output of the Relay Radio Hardware.

A2.14.1 RRH Packet. The schematic of a RRH packet is shown in Figure A2.14.1. 1 (one) packet is placed in each MPR frame. Each packet contains 2 subsections, one for each RRH receiver. Whether data in a subsection is from RRH receiver 1 or 2 is determined from the housekeeping data.

Title	SYNC CODE	RRH RCVR DATA	PROBE DATA	PROBE DATA END	SYNC CODE	RRH RCVR DATA	PROBE DATA	PROBE DATA END
Data Offset	0	8	72	208	216	224	288	424
Bits/ packet	8	64	136	8	8	64	136	8
Description	A2.14.3	A2.14.4	A2.14.5	A2.14.6	A2.14.3	A2.14.4	A2.14.5	A2.14.6

Figure A2.14.1 RRH packet

A2.14.2 RRH sychronicity. The contents of the RRH packets are uniquely determined by data available within the packet.

A2.14.3 Sync code. The contents of the sync code section are shown in Table A2.14.1.

Table A2.14.1 RRH Sync Code

Bit(s)	Measurement	Contents
1-8	Sync code	11001010

|1|2|3|4|5|6|7|8| Sync code Bytes 1, 28

A2.14 RRH receiver data. The contents of the RRH receiver data section shall be as shown in Table A2.14.2.

Table A2.14.2 RRH receiver data

Bit(s)	Measurement	Contents
1	RRH I.D.	0=receiver 2 1=receiver 1
2-4	spare	
5-8	block count	Mod 10 count (determines subcom position; note that this Mod 10 count is different from the orbiter SCLK MOD10 count)

|1|2|3|4|5|6|7|8| RRH Receiver Data Bytes 2, 29

Bit(s)	Measurement	Contents
1	spare	
2	bi-phase lock ambiguity resolver status	0=out of lock 1=in lock
3	frequency lock status	0=out of lock 1=in lock
4	phase lock loop status	0=out of lock 1=in lock
5	threshold C/N	0=23 db-Hz 1=25 db-Hz
6	standby mode status	0=not in standby 1=in standby
7	narrowband mode status	0=not in narrowband 1=in narrowband
8	wideband mode status	0=not in wideband 1=in wideband

|1|2|3|4|5|6|7|8| RRH Receiver Data Bytes 3, 30

Bit(s)	Measurement	Contents
1-8	least significant bits of signal amplitude (1st sample)	8 LSB's of 9 bit word

|1|2|3|4|5|6|7|8| RRH Receiver Data Bytes 4, 31

Bit(s)	Measurement	Contents
1-8	least significant bits of signal amplitude (2nd sample)	8 LSB's of 9 bit word

|1|2|3|4|5|6|7|8| RRH Receiver Data Bytes 5, 32

Table A2.14.2 RRH receiver data

Bit(s)	Measurement	Contents
1-8	least significant bits of signal amplitude (3rd sample - or repeat of 2nd sample if 3rd sample not ready. Availability depends on asynchronononous timing between RRH operating at probe data rate, and CDS collection interval.)	8 LSB's of 9 bit word

|1|2|3|4|5|6|7|8| RRH Receiver Data Bytes 6, 33

Bit(s)	Measurement	Contents
1-8	RRH subcommed data as shown in Tables A2.14.3 through A2.14.7	determined by MOD 10 count in Bytes 2, 29; Bits 5-8

|1|2|3|4|5|6|7|8| RRH Receiver Data Bytes 7, 34

Bit(s)	Measurement	Contents
1-8	RRH subcommed data as shown in Tables A2.14.3 through A2.14.7	determined by MOD 10 count in Bytes 2, 29; Bits 5-8

|1|2|3|4|5|6|7|8| RRH Receiver Data Bytes 8, 35

Bit(s)	Measurement	Contents
1-8	RRH subcommed data as shown in Tables A2.14.3 through A2.14.7	determined by MOD 10 count in Bytes 2, 29; Bits 5-8

|1|2|3|4|5|6|7|8| RRH Receiver Data Bytes 9, 36

A2.14.4.1 <u>RRH receiver subcommed data</u>. The contents of the subcommed RRH receiver data vary with Mod 10 count seen in Byte 2, 29; Bits 5-8. Mod 10 count = 0 is described in Table A2.14.3. Mod 10 count = 2 is described in Table A2.14.4. Mod 10 count = 4 is described in Table A2.14.5. Mod 10 count = 6 is described in Table A2.14.6. Mod 10 count = 8 is described in Table A2.14.7.

Table A2.14.3 Mod 10 count = 0 Subcommed data

Bit(s)	Measurement	Contents
1-8	signal frequency Most Significant Bits	8 MSB's of probe signal frequency (24 bits total)

1 2 3 4 5 6 7 8 RRH Receiver Subcommed Data Bytes 7, 34

Bit(s)	Measurement	Contents
1-8	signal frequency Most Intermediate Significant Bits	8 LSB's of probe signal frequency (24 bits total)

1 2 3 4 5 6 7 8 RRH Receiver Subcommed Data Bytes 8, 35

Bit(s)	Measurement	Contents
1-8	signal frequency Least Significant Bits	8 LSB's of probe signal frequency (24 bits total)

1 2 3 4 5 6 7 8 RRH Receiver Subcommed Data Bytes 9, 36

Table A2.14.4 Mod 10 count = 2 Subcommed data

Bit(s)	Measurement	Contents
1-8	signal amplitude Most Significant Bits	8 MSB's of probe signal amplitude (9 bits total)

1 2 3 4 5 6 7 8 RRH Receiver Subcommed Data Bytes 7, 34

Bit(s)	Measurement	Contents
1-8	real-time image count Least Significant Bits	8 LSB's of SCLK RIM

1 2 3 4 5 6 7 8 RRH Receiver Subcommed Data Bytes 8, 35

Bit(s)	Measurement	Contents
1-8	MOD 91 count	8 bits of SCLK MOD 91

1 2 3 4 5 6 7 8 RRH Receiver Subcommed Data Bytes 9, 36

Table A2.14.5 Mod 10 count = 4 Subcommed data

RRH Receiver Subcommed Data Bytes 7, 34

Bit(s)	Measurement	Contents
1-8	commanded frequency	frequency = (0.3711 DN-15) KHz

RRH Receiver Subcommed Data Bytes 8, 35

Bit(s)	Measurement	Contents
1-8	commanded frequency rate	frequency rate = 0 for DN > -44, or frequency rate = 0.1812 DN Hz/sec. for DN ≤ -44 (DN is in 2's complement form)

RRH Receiver Subcommed Data Bytes 9, 36

Bit(s)	Measurement	Contents
1-8	spare	

Table A2.14.6 Mod 10 count = 6 Subcommed data

RRH Receiver Subcommed Data Bytes 7, 34

Bit(s)	Measurement	Contents
1-8	average phase error	phase error averaged over 128 symbols

RRH Receiver Subcommed Data Bytes 8, 35

Bit(s)	Measurement	Contents
1-8	RMS phase error	absolute value of phase error averaged over 128 symbols

RRH Receiver Subcommed Data Bytes 9, 36

Bit(s)	Measurement	Contents
1-8	noise level	noise power level measured at the output of one of the baseband 512 Hz digital filters

Table A2.14.7 Mod 10 count = 8 Subcommed data

Bit(s)	Measurement	Contents
1-8	command error count	MOD 256 count of rejected commands

|1|2|3|4|5|6|7|8| RRH Receiver Subcommed Data Bytes 7, 34

Bit(s)	Measurement	Contents
1-8	spare	

|1|2|3|4|5|6|7|8| RRH Receiver Subcommed Data Bytes 8, 35

Bit(s)	Measurement	Contents
1-8	spare	

|1|2|3|4|5|6|7|8| RRH Receiver Subcommed Data Bytes 9, 36

A2.14.5 Probe data. The contents of the probe data section is shown in Table A2.14.8

Table A2.14.8 Probe data

Bit(s)	Measurement	Contents
1	first probe symbol start	0
2-4	first probe symbol	3 bits representing the first probe symbol
5	2nd probe symbol start	0
6-8	2nd probe symbol	0 2nd probe symbol

|1|2|3|4|5|6|7|8| Probe Data Bytes 10, 37

Bit(s)	Measurement	Contents
1	3rd probe symbol start	0
2-4	3rd probe symbol	3 bits representing the first probe symbol
5	4th probe symbol start	0
6-8	4th probe symbol	0 2nd probe symbol

|1|2|3|4|5|6|7|8| Probe Data Bytes 11, 38

And so on until Bytes 26, 53

Table A2.14.8 Probe data

Bit(s)	Measurement	Contents
1	33rd probe symbol start	0
2-4	33rd probe symbol	3 bits representing the 33rd probe symbol
5	34th probe symbol start	0
6-8	34th probe symbol	3 bits representing the 34th probe symbol

|1|2|3|4|5|6|7|8| Probe Data Bytes 26, 53

A2.14.6 Probe data end. The contents of the probe data end section may be either an additional probe symbol and an end word, or merely an end word. If byte 27,54; bit 1 is 0, the data is shown in Table A2.14.9. If byte 27,54; bit 1 is 1, the data is shown in Table A2.14.10.

Table A2.14.9 Probe data end (for byte 27,54; bit 1 = 0)

Bit(s)	Measurement	Contents
1	35rd probe symbol start	0
2-4	35rd probe symbol	3 bits representing the 33rd probe symbol
5-8	end of probe data symbols	1111

|1|2|3|4|5|6|7|8| Probe Data End Bytes 27, 54

Table A2.14.10 Probe data end (for byte 27,54; bit 1 = 1)

Bit(s)	Measurement	Contents
1-8	end of probe data symbols	11111111

|1|2|3|4|5|6|7|8| Probe Data End Bytes 27, 54

A2.14.7 Telemetry Mode Changes. Upon application of system power, RRH shall automatically configure itself to an operational mode. All data shall be valid.

A2.15 OPEN ITEMS AND TBD'S.

All TBD items in this document are listed in Table A2.15.1. All known open items are listed in Table A2.15.2.

Table A2.15.1. GLL-3-280 TBD Items

PAGE	IDENTIFICATION	ITEM	RESPONSIBLE ENGINEER	REQUIRED CLOSURE DATE
34	3.8.3.5	Back up Science (BUS) elements	P. Beyer	1/1/85
	Table A2.2.9	Assign CDS Digital and Software bit Definitions	W. Kohl	10/15/82
	Table A2.2.9	Assign AACS Digital and Software bit Definitions	J. Rhoads	10/15/82

Table A2.15.2. GLL-3-280 Open Items

PAGE	IDENTIFICATION	ITEM	RESPONSIBLE ENGINEER	REQUIRED CLOSURE DATE
		NONE		

REVISION PAGE

Revision	Date	ECRs Incorporated	Comments
Original Issue	15 Jun 1979		
Revision A	4 Aug 1980	23011, 23020, 23031, 23034, 23036, 23052, 23058, 23060, 23061, 23071, 23288, 23323, 23339	
		23002, 23027, 23032, 23056, 23064, 23096, 23260, 23266, 23269, 23271, 23277, 23281, 23282, 23283, 23302, 23316, 23326, 23333, 23338, 23345, 23371, 23374, 23377, 23388, 23406, 23408, 23409, 23410, 23420, 23430, 23439, 23441	Closed by Amendment 1 (13 Jan 1981)
		23089, 23095, 23329, 23344, 23399, 23401, 23407, 23412, 23432, 23464, 23499, 23523, 23543, 23565, 23593	Closed by Amendment 2 (17 Jun 1981)
		23423, 23471, 23479, 23551, 23561, 23564, 23569, 23578, 23585, 23589, 23594, 23620	Closed by Amendment 3 (5 Nov 1981)
		23542, 23545, 23610, 23632, 23737, 23647, 23650A, 23675A, 23709, 23719, 23721, 23722, 23723, 23728, 23768, 23769, 23775, 23801, 23830, 23857, 23858	Closed by Amendment 4 (15 Sept 1982)

REVISION PAGE

Revision	Date	ECRs Incorporated	Comments
Revision B	13 Dec. 1982	23405, 23431, 23658, 23695, 23712, 23729, 23733, 23737, 23767, 23812, 23816, 23829, 23834, 23838, 23839, 23843, 23850, 23860, 23877, 23891, 23918, 23981	
		23342, 23682, 23767A, 23825, 23871, 23899, 23925, 23933, 23955, 23978, 23983, 24027, 24035, 24036, 24039, 24040, 24055, 24076, 24096, 24111, 24127	Closed by Amendment 1 (3 June 1983)
		23866, 23959A, 24009, 24103, 24118, 24120, 24141, 24156, 24157, 24189, 24194, 24206, 24207, 24222, 24226	Closed by Amendment 2 (1 December 1983)
		23693, 24003, 24077, 24165, 24170, 24183, 24212, 24213, 24215, 24224, 24234, 24241, 24263, 24294, 24315, 24342, 24348, 24405, 24434	Closed by Amendment 3 (30 August 1984)
		24338. 24344A, 24366, 24435, 24447, 24492, 24505, 24536, 24545	Closed by Amendment 4 (15 March 1985)
Revision C	15 Jan. 1986	24344B, 24551A, 24582 24602, 24668, 24672, 24690	

REVISION PAGE

Revision	Date	ECRs Incorporated	Comments
Revision D	1 Mar. 1989	24768, 24773A, 24867, 24906, 24908, 24947D, 24948B, 24951, 24952E, 24953C, 24954D, 24956A, 24959A, 24961B, 24962A, 24986C, 24993E, 24997B, 35023, 35026, 35031C, 35034, 35059A, 35063A, 35155, 35163A, 35175B, 35277	
Change 1	1 Aug 1989	35034A, 35242, 35244B, 35279, 35298, 35299, 35309, 35312, 35334, 35341	